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Strategy To Reverse Critical Energy Shortfall Discussed

916B0075A Beijing JINGJI RIBAO in Chinese 10 Jun 91 p 3

[Article by reporter Xie Ranhao [6200 3544 3185]: "Objective: Preliminary Reversal of Serious Energy Resource Shortage, Energy Resource Industry Draws Up 10-Year Plan, Huang Yicheng [7806 3015 6134] Discusses Future Development Strategies and Measures"]

[Text] "The Eighth 5-Year Plan and the next 10 years are an important decade in China's achievement of its second step of strategic objectives. The energy resource industry must strive to avoid falling further behind over the next 10 years and achieve a preliminary reversal in the severe energy resource shortage situation to ensure sustained, stable, and coordinated development of our national economy and meet the requirement of attaining relatively prosperous living standards for our people." This statement was made by Ministry of Energy Resources minister Huang Yicheng during a discussion of the Eighth 5-Year Plan and the 10-Year plan formulated for the energy resource industry.

While meeting with reporters, Huang Yicheng said that, calculating on the basis of a 6 percent annual increase in GNP and 6.1 percent increase in the yearly value of industrial and agricultural output over the next 10 years, the yearly growth rate for primary energy resources can be no less than 3 percent. This will pose a corresponding requirement of increasing total output of primary energy resources to 1.2 billion tons of standard coal by 1995 and 1.4 billion tons of standard coal by 2000.

Huang Yicheng said that, based on this objective, the primary strategic deployments and measures for development of energy resources in China in the future are:

Take full advantage of China's abundant coal resources and accelerate the development of coal. The focus will be on developing coal in Shanxi, Shaanxi, and western Inner Mongolia in conjunction with accelerating development of coal in northeast China in an attempt to increase China's total raw coal output by about 40 million tons a year over the next decade.

Take full advantage of China's abundant hydropower resources and accelerate hydropower construction. The focus will be on construction of large and medium-sized hydropower stations on the upper reaches of the Huang He, the trunk and tributaries of the Chang Jiang, and the Hongshui He, Wu Jiang, and Lancang Jiang in an effort to increase the installed generating capacity at large and medium-sized hydropower stations by 10,000MW during the Eighth 5-Year Plan. At the same time, several pumped-storage power stations will be built to meet power grid peak regulation requirements.

Actively develop pit-mouth thermal power plants, strengthen power grid construction, and shift from hauling coal to transmitting electricity to reduce the pressures on transportation. The initial plans call for construction of about 30,000MW in pit-mouth power plants over the next decade, which could conserve an estimated 100 million tons in coal haulage capacity.

Move quickly to gain a grasp of nuclear power plant construction technology. At present, this mainly involves moving quickly to gain a grasp of manufacturing technology in an effort to achieve a shift to domestic production of nuclear power equipment as soon as possible to reduce nuclear power plant construction costs and create the conditions for more rapid development of nuclear power in China after the year 2000.

Reinforce petroleum and natural gas exploration and development. We will strive to increase crude oil output by 2 million tons a year during the Eighth 5-Year Plan. At the same time, we will continue to implement policies to reduce the burning of oil and burn 2 million tons less of petroleum a year.

Focus on rural energy resources and rural electrification construction. Expand the coverage rate of power grids in rural areas, build medium-sized and small hydropower stations, and develop wind-powered electricity generation, solar energy power stations, and so on in frontier regions to gradually solve the power supply problems of the 32 counties and population of 190 million without electricity at the present time.

Rely on scientific and technical progress and scientific management, strive to increase labor benefits and labor productivity in energy resource enterprises, and reduce environmental pollution. The coal industry should strive for a mechanization level of greater than 80 percent and full-staff labor productivity of 2 tons per manshift by the year 2000. Consumption of coal for power generation in the engineering industry should be reduced by an average of 4 to 5 grams/kWh each year in an effort to reduce it by 60 to 70 grams by the end of this century.

Huang Yicheng stressed that the key to strengthening energy resource development and construction in China over the next decade is to increase capital inputs in the energy resource industry, straighten out energy resource prices, and strengthen the vitality of energy resource enterprises. To achieve this, we must continue extensive implementation of the policy of reform and opening up. Besides the need for continued intensification in electric power construction, perfecting the policy adopted in the 1980's of "those who invest being those who benefit", and implementing multiple channels, multiple levels, and multiple models to raise capital to develop power and establish electric power construction funds, coal and petroleum should also establish similar special purpose construction funds to ensure capital inputs.

Suggestions for Accelerating Development of the Energy Industry

916B0079 Beijing ZHONGGUO NENGYUAN [ENERGY OF CHINA] in Chinese No 6, 25 Jun 91 pp 1-4

[Article: "Suggestions on Ways and Means To Accelerate Development of the Energy Resource Industry, Proposals From 1st Full Session of Ministry of Energy Resources Senior Consulting Committee Members (Part Three)" For parts One and Two, see JPRS-CEN-91-007, 16 Jul 91, pp 4-10]

[Text]

VII. On the Question of Energy Resource Transportation

Yang Hongnan [2799 3163 1628]: 1) We must focus on coal development and electric power construction deployments and make overall plans for and coordinate the development of communication and transportation construction. The basic directions for the flow of coal in China are for coal from west China to be shipped to east China, for coal from north China to be shipped to south China, and for coal to be shipped out of the central Shaanxi plain. The new change in the direction of coal flows in the Eighth 5-Year Plan and the next 10 years is for coal to be shipped from north China into Sichuan. The capacity of the Bao-Cheng [Baoji-Chengdu] and Xiang-Yu [Xiangfan-Chongqing] railroads is rather low and it would involve a substantial cost to ship large amounts of north China coal into Sichuan, so we can think of several ways to solve the problem. One is upgrading existing railroads to enable them to handle part of the coal hauled into Sichuan. Another is to build power plants on the southern side of the energy resource base area centered on Shanxi and transmit power to Sichuan. A third is to develop hydropower and nuclear power in Sichuan. Preliminary calculations indicate that to supply coal from the energy resource base area to thermal power plants in various locations, the investment in transport construction per kW would be 1,000 yuan in Shanghai, 1,110 yuan in Xiamen, 1,200 yuan in Guangzhou, 700 yuan in southern Liaoning, and 1,500 yuan in Chengdu. Shipping coal from north China into Sichuan would be the most difficult and the most costly. If we develop nuclear power in Sichuan, the benefits from conserving transportation could partially compensate for the problem of the high cost of nuclear power. This should receive attention in future nuclear power deployments.

2) We should focus on research and development of new energy resource shipping technologies. By building dual-track electrified railroads and opening them to heavily loaded single unit trains, the coal haulage capacity could reach 100 to 150 million tons or even more. This type of transportation capacity alone would not be enough, however. Building clusters of pit-mouth power plants in coal base areas and transmitting power out is another transportation capacity arrangement. Past comparisons of 330 kV or 500 kV power transmission lines with railroads when the heat output of coal was about 16,750 kilojoules indicated that long-distance power transmission was not economical, but there would be significant economic benefits from developing new extra-high voltage 750 kV or 1,150 kV power transmission technology. Another route is pipeline transmission of coal, and we should select appropriate sites and match them with power plants for industrial experiments.

VIII. The Question of Increasing the Degree of Coal Resource Exploration

Wei Tong [7614 0681]: China is not rich in coal resources in per capita terms, and the extent of exploration is also low. The proven reserves in the 1991 table of China's coal resource reserve balance was 901.4 billion tons, which is the sum of the four grades of reserves, A, B, C, and D. Among them, grade D is coal reserves found through surveys and they have no industrial extraction value. There is extraction value only moving up to grade C. However, grade D reserves now account for more than one-half of our existing proven reserves. Actually, we have only 260 billion tons of carefully surveyed reserves that could be utilized and if we deduct those that have already been taken over and those that are hard to utilize for the time being, we only have 37 billion tons, which cannot even meet the requirements for coal mine construction starts during the Eighth 5-Year Plan, and we do not have any superior quality leeway. There are two main reasons for this situation: 1) The term "proven reserves" used for coal is inappropriate and has led to considerable misunderstanding. The highest grade of petroleum reserves, for example, refers to reserves that are calculated after oil field evaluations are completed. They are the highest grade petroleum reserves and correspond to carefully surveyed reserves for coal, but proven reserves of coal have not been proven. 2) During the Seventh 5-Year Plan, the state reduced exploration funds for geological activities, which led to a reduction in the amount of prospecting engineering. We now spend just 47 million yuan on exploration each year and only complete 1.2 million meters of engineering, so we have a capital shortage of one-half. To ensure construction starts for 360 million tons during the Eighth 5-Year Plan and Ninth 5-Year Plan, we should submit 700 million tons of detailed surveyed reserves and do 2.4 million meters of exploratory drilling engineering each year for 5 years. I propose that 1 yuan be deducted per ton of coal for use as a geological exploration fund.

IX. On the Question of Increasing Efficiency at Unified Distribution Coal Mines

Wu Dijing [0702 6611 0311]: The Ministry of Energy Resources has pointed out that full-staff efficiency at unified distribution coal mines should reach 2 tons of raw coal by the end of this century. I will discuss some views here.

A. Analysis of raw coal full-staff efficiency at China's unified distribution coal mines.

In 1989, China's unified distribution coal mines had 87 mining bureaus and a raw coal full-staff efficiency of 1.146 tons/manshift. These 87 mining bureaus fell into three categories. Category 1 includes 10 bureaus with relatively superior extraction conditions. They had an average coal seam production capacity of 3.79 tons/m^2, coal mining working face lengths of 114.17 m, a coal extraction mechanization extent usually from 80 to 100 percent, unit output per coal extraction working face of 27,314 tons/month, and an average full-staff efficiency of 1.5 tons/manshift. The highest were Jincheng at 4.687 tons/manshift and Lu'an at 4.001 tons/manshift.

In category 2, the coal seams and extraction conditions were moderate and above, and there were 47 mining bureaus. They had an average coal seam production capacity of 3.13 tons/m^2, coal mining working face lengths of 111.25 m, a coal extraction mechanization extent of 54 percent, average unit output per working face of 14,606 tons/month, and full-staff efficiency of 1.1 tons/manshift.

In category 3, the coal seams and extraction conditions are both very poor, and there were 30 mining bureaus. They had an average coal seam production capacity of 2.61 tons/m^2, coal mining working face lengths of 73.01 m, a coal extraction mechanization extent of 29 percent, unit output per working face of 6,788.75 tons/month, and a full-staff efficiency of 0.68 tons/manshift.

B. Basic ideas for further improvements in efficiency.

1. Implement guidance by categories. Category 1 has great potential and we should continue a substantial push forward. Category 2 should be stabilized and improved. Category 3 should be supported and there should be some improvements instead of reductions in efficiency.

2. Develop large open-cut mines. Strip mines have short construction schedules and high efficiency and all countries are focusing on extraction in large open-cut mines. Output from strip mines in the main coal-producing nations as a proportion of their coal output has risen from 25 percent in 1960 to 43 percent in 1988, but China's strip mines only account for 3 percent. China's coal fields have 58 billion tons of reserves that could be extracted through strip mining. We should increase the intensity of open-cut extraction in the future and try to build 100 million tons in new strip mining capacity by the end of this century.

3. Develop mechanization of mining and tunneling focused on fully-mechanized mining and fully-mechanized tunneling, rationally centralize production. Category 1 mining regions can focus on developing fully-mechanized extraction. Category 2 mining regions should adapt to local conditions and develop different levels of mechanization. Category 3 regions should adopt various types of technical measures, including minor upgrading and minor innovation, to increase efficiency.

4. Reinforce scientific labor management based on quotas and fixed personnel and improve the labor use system. All units should revise quotas and personnel assignment standards, implement raw coal labor use plan management, further rectify labor organization, and improve rotating peasant employee utilization methods.

5. For mines with poor conditions, low efficiency, and serious losses, adopt a transition to collective administration and other special policies, develop economic diversification, and make arrangements for surplus personnel.

X. On the Question of Reform in Unified Distribution Coal Mines

Ge Fu [2047 1133]: 1. Unified distribution coal mines are enterprises which have the most deeply branded traditional planned economy and product economy models and they are enterprises with the least vitality at present. They are the only industry among the seven major industries that have implemented contractual responsibility which has been unable to rely entirely on self- accumulation for self-development and they have even been unable to maintain simple reproduction. There is still no unity of understanding at present in regard to whether or not unified distribution coal enterprises should convert to commodities, whether or not unified distribution coal mine should become commodity production administrators in accordance with the law who make their own administrative decisions, have responsibility for their own profits and losses, and depend on self-development and self-restriction. Unity of understanding is essential for promoting reform in unified distribution coal mines.

2. There are major defects in the present dual-track system for coal mine construction and production administration. There is no responsibility over decisions concerning how coal mines are to be built and the results of management after they are completed and begin operating. Those responsible for production management have no authority to interfere and make decisions concerning whether or not coal mine construction is rational. Doing things this way does not help shorten construction schedules and increase economic benefits, and it should be improved.

3. There must be identical directions for industrial policies and price policies. At present, the state's industrial policies must be slanted toward basic industry and must accelerate construction of unified distribution coal mines, but price policies are not adapted to this. This problem must be conscientiously studied and resolved.

4. There should be reform of the industrial structure and product mix for coal mines. If coal mines are simply involved in initial product production, there is no way they can operate over the long term. They should take

the route of comprehensive development, comprehensive administration, comprehensive utilization, and intensive processing of coal's paragenetic and associated minerals.

5. There must be an outline of goals and an overall medium-term plan for reform of the coal mining industry. For example, how can the principle of combining the planned economy with market regulation be achieved in the coal industry? How can unified distribution coal mines become economic entities that make their own administrative decisions and have responsibility for their profits and losses? And so on. There should be an outline of goals and a medium-term plan and there should be measures for their implementation in steps.

XI. On the Question of Energy Conservation and Developing New Energy Resources

Zhu Hongfei [2612 3163 7378] and **Zhu Shiwei** [2612 0013 0251]: Technical upgrading and energy conservation are one of the key issues in achieving the "two results". Besides energy conservation in the energy resource system, we should also be concerned with energy conservation in the metallurgical, chemical, construction materials, textiles, and the machine building and electronics industries as well. These are the foundation of economic development and major energy users, and we should suggest energy conservation proposals and policies for them.

With the emergence of high technology, new energy resources have revealed a powerful vitality. Besides nuclear power, development and utilization of solar energy, wind energy, biogas, tidal energy, bioenergy, geothermal energy, and so on have grown substantially internationally. China's solar water heaters have already attained scale production and solar stoves have been warmly welcomed in agro-pastoral regions of west China. Development work on solar batteries is now tracking world development levels and there is major potential for biogas utilization. In summary, new energy resources are an important part of China's energy resources and have great prospects. The situation now is one of too many managers with no one involved in concrete administration. This system is very ill-adapted. We should strengthen forces to achieve responsibility over management of new energy resources.

XII. On the Question of Relying on Science and Technology To Develop Energy Resources

Ni Weidou [0242 4850 2435]: Energy resources are the foundation of our national economy and involve projects of vital and lasting importance. There should be long-term programs and S&T progress should play a major role.

1. We should focus on extension of somewhat leading mature and appropriate science and technology. For example, many power plants are using new types of burners with rather good results but they have not been sufficiently promoted. Another example is coal-burning combined cycles which include coal gas, circulating fluidized beds, and so on. There have been major advances and retreats and very good arrangements have never been made. All the world is working on combined cycles but we are moving very slowly.

2. We should foster the efficiency of existing power generation equipment. The efficiency of much power generation equipment is very low now, which is related to the quality of operating personnel as well as to imperfections in monitoring and control equipment. We should develop simulators for training and the direction for power plants and power grids is to promote the use of simulators. The investments would not be that great and they could quickly raise the technical levels of operating personnel, reduce generator shutdowns, and reduce line losses, so the economic benefits would be good. Another example is the monitoring and control problems of 200MW generators. Because of past shortages, adding a small amount of monitoring and control equipment, selecting optimum operation, and reducing vibration would produce optimum results.

3. The utilization efficiency of coal at present is low and there is substantial potential that could be exploited. Developing several 4 ton, 10 ton, 25 ton, 35 ton, and 65 ton circulating fluidized bed boilers, for example, could increase efficiency by 85 percent. Ventilators and water pumps used in coal mines consume large amounts of energy and should be improved. If we use new technology to conserve energy, we cannot rely entirely on doing our own development. With policies and powerful provisions, extension would move faster.

XIII. On the Question of Increasing the Economic Benefits of Energy Resource Construction

Huang Zaiyao [7806 6528 1031]: 1. We must deal properly with the relationship between construction scales and reducing construction schedules in the energy resource industry. In a situation of capital shortages, overly-large scales of construction starts could affect construction schedules. During the Eighth 5-Year Plan, with a prerequisite of maintaining an appropriate scale of construction starts, we should focus on shortening construction schedules.

2. Hydropower development should choose rivers with good development conditions and carry out cascade development of entire basins. We should build tap power stations with good regulation properties first and build somewhat fewer runoff type hydropower stations and avoid having too much redundant capacity in power grids. It would not be appropriate to begin construction of huge hydropower construction projects during the 1990's to prevent capital tieups.

3. We must focus on assessment work and preparatory work for large construction projects and avoid making mistakes during construction.

4. We must focus on research on economic policies and research on management systems.

XIV. Views and Proposals on Developing the Energy Resource Industry

Zhang Xianhong [1728 2009 1347]: 1. Development of energy resources should not be synchronized with an overheated economy but should instead play a controlling role.

2. When energy resources are relaxed, we should slow the speed of development, improve the quality of energy resources, reduce the price of energy resources, and readjust the structure.

3. We should give preference to developing hydropower and shift investments to develop coal over to hydropower. This is a long-term policy, and I am afraid it will take 20 to 30 years. We should try to reduce coal-fired power generation as much as possible.

4. We should accelerate development and trial utilization of nuclear power. This is a clean, convenient, and flexible power source with hope for the 21st Century.

5. Stop using low-efficiency thermal power generators. Some can be converted to heat and power cogeneration and others can be retained as "reserves" for short-term use during shortages or excessive amplification.

6. Energy resources should participate in market regulation activities and there can be different prices for different regions, different industries, different users, and different periods.

7. Actively promote "power use rights", "coal use rights", and "oil use rights".

8. Promote contractual negotiated prices for power, coal, and oil supplies, implement fixed sites, fixed directions, fixed regions, fixed times, fixed amounts, and fixed prices, and eliminate large amounts of accumulation, reduce fluctuations, and reduce the unevenness of benefits for upstream and downstream areas.

9. Permit buying and selling on credit and "installment loans", but interest should be collected and interest should be paid on debts owed to the state. Each side should support the other, but there should be profits.

10. Study "installment loan" and "buying and selling on credit" systems. Products can be sold to prevent inflation, control supplies and markets, and help in capital allocation.

11. Equal prices for equal quality and equal amounts should gradually be implemented for electricity and energy resources. The long-term goal is orientation toward international prices to promote improvements in processing industry levels.

12. During periods of shortages, the profits from energy resource prices should equal the profits in processing industries.

13. Projects which utilize foreign investments should be strictly controlled. When the interest on foreign investments is greater than the rate of growth in our national economy, it is usually best not to use them for energy resource construction and instead to use them for importing high, incisive, and precision equipment that is in short supply or not available or to produce goods that provide quick benefits. For example, our GNP now is $\approx$ 6 percent. Unless it exceeds 6 percent, we must be careful in their use.

Try as much as possible to use domestic supplements like loans, bonds, stocks, and so on.

20,000MW in Added Capacity To Go Into Operation in Two Years

91P60252 Beijing RENMIN RIBAO in Chinese 17 Jul 91 p 1

[Article by Zhang Chaowen [1728 6389 2429]]

[Text] From 13 to 15 July, the Ministry of Energy Resources convened a mobilization meeting in Shentou appealing to electric power construction workers throughout the country to work in coordination to ensure that large and medium-scale generating units can be put into operation to generate 10,000MW this year and next year in order to pave the way for national economic expansion in the 90's.

According to what this reporter learned from the related departments, the official electric power construction plan this year is to put 6,530MW in large and medium-scale generating units into operation. However, after study, the Ministry of Energy Resources deems that in order to have an annual growth rate of 6% in the GNP over the next decade the annual growth rate in electric power must be 7%. Based on the 7% figure, more than 10,000MW in large and medium-scale generators must be built. Therefore, it is necessary to put 20,000MW into operation in 2 years.

Being the fourth largest electric power country in the world, China today has a generating capacity of 138 million KW and its annual output is 621.3 billion kWh. However, compared to the rapid growth of industrial and agricultural output and living standard, the development of the electric power industry lags far behind. China's electric power shortage has gone on for 21 years. From the experience of national electric power system expansion in Shandong, the Ministry of Energy Resources has decided to share the country's burden and strive to revese the electric power shortage situation in China in the 90's.

600MW Sub-Critical, Supercritical and Nuclear Generating Sets

40100068 Beijing CHINA DAILY (SHANGHAI FOCUS) in English 15 Jul 91 p 1

[Article by Chen Qide: "Power for the Future"]

[Text] Electricity generating sets are being developed in Shanghai to assist the country's quick economic growth, said an official from the Shanghai United Electric Corporation.

They include sub-critical, supercritical and nuclear generating sets of 600,000 kilowatts.

"These are considered critical projects for the company in the next five years," said Dr. Zeng Hong, section chief of the Plan and Capital Construction Office with the corporation.

However, developing such high-tech products was a difficult and expensive job, he said, adding that the city planned to invest about 600 million yuan in the projects.

With economic expansion, the country calls for large capacity generating sets. According to Zeng, Shanghai puts focus on the development of thermal and nuclear power plants, aimed at generating more electricity for civilian use with lower costs. In the past five years, the city has invested 210 million yuan in its four large works—the Shanghai Turbine Works, the Shanghai Electrical Machinery Manufacturing Works, the Shanghai Boiler Works and the Shanghai Power Station Auxiliary Equipment Works.

Now the four producers have the capacity to turn out 10 million kilowatt products through the import of advanced equipment from abroad worth $16 million, Zeng said.

Preparatory plans and designs are being drawn up, "but it is still not settled who will contract the items," he said.

Shanghai accumulated experience after its part in constructing the Qinshan Nuclear Power Plant, at Qinshan in Zhejiang's Haiyan County. "So it will be much easier for the city to manufacture 600,000-kilowatt nuclear generating sets," he said.

But Shanghai is challenged by Harbin which wants to win the tender. According to Zeng, both are expected to join hands for the objective.

Preparations are being carried out, he said. The Shanghai Turbine Works has turned to foreign transnational corporations, introducing advanced technology from America's Westinghouse Corporation to turn out 600,000-kilowatt sub-critical turbines.

According to Yao Ertang, deputy director of the Technology Department of the works, the turbine works is cooperating with Sweden's Asea Brown Boveri (ABB) for the production of 600,000-kilowatt super-critical turbines, which are to be used in the second-phase project of the city's Shidongkou Power Plant.

Apart from this, the works has also signed an agreement with ABB Company which states that the works can turn out turbines with its Swedish partner for any Asian customer in the following three years.

Meanwhile, the city's Electrical Machinery Manufacturing Works has invested 48.4 million yuan in its technical innovation in the past five years.

"The large infusion of funds has updated the works' capability to process key equipment," said Zeng Hong.

Now the Shanghai corporation has increased capacity to turn out thermal generating sets through the 160-million-yuan technical renovation, he said.

China Becomes One of Few Nations To Export Power Plant Control Computers

916B0075B Shanghai JIEFANG RIBAO in Chinese 22 May 91 p 1

[Article by reporter Zhang Zhiyuan [1728 1807 6678]: "China's Large-Scale Power Plant Control Computers Enter International Market, Xinhua Power Plant Control Engineering Company Fosters Its Advantages, A Power Plant Controlled By Chinese Computers Goes Into Operation in Pakistan"]

[Text] Since the history of China's dependence on imports for power plant control computers came to an end, we have leapt into the few countries of the world that are capable of manufacturing and exporting this type of high-tech equipment sets. Three "Chinese-made" power plant computers indicating this historic change have been installed at Pakistan's (Jiamuxiaoluo) power plant and they have displayed excellent quality and performance since going into operation and attracted the attention of colleagues in all nations of the world.

This historical transformation in the high-tech realm was made through 2 and ½ years of arduous efforts by over 100 S&T personnel at the Xinhua Power Plant Control Engineering Company, Ltd., which is located in Minxing Development Zone.

For years, we have had to import all of the computer systems used to control the operation of large power plants in China. Whenever a breakdown occurred in these special computers, which are called the "central nervous system" of a power plant, the entire power plant suffered. Electric power is the lifeline of our country and without domestic-made power plant computers, one end of this lifeline had to remain in the hands of other people.

To bring an end to this passive situation, S&T personnel in the Xinhua Power Plant Control Engineering Company dared to be the first and led research in China on power plant control computers at advanced world levels. They imported technology at advanced world levels of the present era, engaged in joint design and production with foreign companies, and used other routes to rapidly raise and strengthen themselves. In 2 and ½ years, they successfully developed five types of computer products for use in large power plant monitoring and control, increasing thermal efficiency and energy conservation, breakdown recall recording, and so on in which the

average degree of domestic production was 80 percent. The primary technical indices attained the standards of the Westinghouse Company in the United States, which are at advanced world levels in the present era, and they received state major technical equipment achievement awards. The cost of Xinhua Company's products is less than half that of similar imported equipment, so they have moved rapidly into all areas of China and are being installed in many key energy resource construction projects. There are now 36 large power plants with installed generating capacities of 300 to 1,200MW like Shidongkou in Shanghai, Pingwei in Anhui, Hanchuan in Hubei, Huangtai, Weifang, and Hualu in Shandong, Tieling in Liaoning, Shalingzi in Hebei, Changshu in Jiangsu, and others which have installed or used equipment produced by the Xinhua Company. The company's per capita annual output value has reached 280,000 yuan.

The Xinhua Company was not satisfied with its successes in domestic markets. They calmly analyzed the feasibility of participating in international competition. Enterprises like Xinhua Company are called systems engineering companies in foreign countries and are dedicated to the "integrated" business of designing and developing high-tech control systems in small numbers and supplying them in complete sets. Xinhua Company manager Li Peizhi [2621 1014 2784] said "this is a form of high-level mental labor output and Chinese S&T personnel have great advantages in this area". All of the company's 100-plus S&T personnel "charged" into the international market. They implemented special "three insurance services" for their products in which they paid 100 percent compensation for property losses caused by product quality, accepted 100 percent of returned goods which affected operation, and provided 100 percent of repair costs for repairs required because of quality problems. At the same time, on the basis of debugging until all of their own products met specifications, the Xinhua Company connected its equipment and devices with their own emulators and conducted closed-loop operation for 3 consecutive months to simulate power generation at a power plant to ensure their quality and reliability. These measures won the trust of users, including foreign guests and businessmen, and Xinhua products, China's only complete sets of computer control equipment, entered international markets in one fell swoop. The Xinhua Company is now developing markets in southeast Asia, Africa, Australia, and other regions and has established offices in the United States, Soviet Union, Hong Kong, and other countries and regions.

Construction Accelerated on Southern Energy Base

916B0076A Beijing JINGJI RIBAO in Chinese 25 May 91 p 1

[Article by reporter Zhang Jianming [1728 0494 0839]]

[Text] In the next decade, in the southern energy base now under intensified construction, in the lofty mountains of Yunnan, Guizhou, and Guangxi Provinces, dozens of hydroelectric stations and thermoelectric power plants will be completed for a total installed capacity of 30 million kW, and in time they will be supplying high loads of power to the eastern regions. The hydropower resource potential of the major river systems of the Lancang, Hongshui, and Wu rivers now under development is as high as 35 million kW, and may be rated the mother lode of all the hydropower resources of China. Not only do the three provinces have these rivers, so rich in hydropower resources, but the coal resources in Yunnan and Guizhou needed for development of thermoelectric power have proven reserves of up to 66 billion metric tons, the richest of the southern provinces.

In order to construct and develop the southern energy base and solve the serious power shortages of the coastal regions, beginning in the 80s, large sums of central and local funds will be put into the completion of construction on the Hongshui He, and a series of large and medium sized hydropower stations, starting with Lubuge. The Tianshengqiao 1st and 2nd cascade stations, and the Yantan and Manwan power stations now under construction, which have average installed capacities of over 1.2 million kW, bring the construction of hydropower stations along this river system into a large-scale development stage. Besides the Wu Jiang power station already completed in the Wu Jiang system, the dam for another large station, the Dongfeng hydropower station, is being poured night and day. Along with the development of hydroelectric resources, the construction of thermoelectric power stations in the south is also proceeding vigorously. The Guizhou Panxian 600,000 kW pit-mouth thermoelectric power plant and other thermopower projects being built by a three-member joint venture will reap enormous benefits in the next few years.

Concurrent with energy development in the southwest, an electric power corridor connecting the bases with Guangdong port areas is spanning the countless mountains and valleys of Guizhou, Guangxi, and Guangdong. The first 500,000 volt extra-high power transmission line, the Tian-Guang line, which begins in the west at Tianshengqiao 2nd-cascade power station on the Guizhou-Guangxi border, leads directly to the Pearl River Delta, some 1,000 km distant, will begin transmitting power next year. Another transmission line to Guangdong constructed in conjunction with the Tianshengqiao 1st cascade station will begin full operations this year. In addition, the National Energy Investment Corporation and the China Southern Electric Power Joint Management Corporation, which was established jointly by Yunnan, Guizhou, Guangxi, and Guangdong, will fund the erection of major transmission lines—the Lu-Tian line from Lubuge to Tianshengqiao, and the Tian-Gui line from Tianshengqiao to Guiyang—which will extend the electric power corridor deep into the southwest power bases, and also will finally unite the power networks of Yunnan, Guizhou, Guangxi, and Guangdong into one body. This will form a southern power network that will send electricity from the west to the east.

50,000KW Gas Turbine Goes on Stream

916B0076B Beijing ZHONGGUO KEXUE RIBAO [CHINESE SCIENCE NEWS] in Chinese 4 Jun 91 p 2

[Article by reporter Huang Jin [7806 6580]]

[Text] After several years of struggle, technicians of units from the CAS Institute of Electrical Engineering, the Shanghai Electrical Machinery Factory, and the Shanghai Extra-High Voltage Transmission and Transformer Corporation completed the 50,000 kW vapor-cooled gas-turbine generator—a national key industry test project—which has joined the network at a transformer station in a western suburb of Shanghai and has begun generating electricity. It is the world's first officially operating vapor-cooled gas turbine generator (stator), and therefore signifies China's leadership in this technical field.

Electrical machinery vapor cooling is a new cooling technology, and has importance in raising the overall efficiency of generator units. Researchers Gu Guobiao [7357 0948 1753] and Li Zuozhi [2621 0155 0037], and young comrades Fu Deping [0102 1795 1627] and Xu Song [1776 2646] overcame many obstacles in completing a series of research and testing tasks and broke new ground for giving life and smooth operations to industrial units.

According to the experts, because this generator uses vapor cooling technology, compared to conventional generators, it has reliable power, ease of operations, uniform distribution of cooling temperature, and unmatched fire and explosion prevention qualities. The cost of materials is 5 to 10 percent lower than for other types of generators, its generating efficiency can be raised 2/1000ths, and it has prospects for huge economic gains and wide applications.

The Ministry of Machine-Building and Electronics Industry, CAS, and the Ministry of Energy Resources invited a body of experts to do an on-site appraisal and assessment of the operations of the 50,000 kW vapor-cooled gas turbine generator. The experts believe that the success of this project and its smooth entry into the grid lays a solid foundation for the development of large-size gas generators.

The chief of the leading team for this project, former Bureau Chief of the CAS Technology and Science Bureau, Zhang Hong [1728 1347], said the smooth completion of this unit is the product of the cooperation of various ministries and the result of research, design, production, and application elements all working together.

State Planning Commission Gives Go-Ahead for 300MW Daxia on Yellow River

40100065A Beijing CHINA DAILY (Business Weekly) in English 8 Jul 91 p 4

[Article by Huang Xiang: "More Power From Yellow River"]

[Text] China will soon start construction of a long-awaited hydro-electric power project on the Yellow River, signalling a new round of water and power undertakings on the river's upper reaches.

The construction of Daxia hydropower station, in Northwest China's Gansu Province, was recently given the go-ahead by the State Planning Commission. But the date of construction has yet to be fixed.

Located on the borders of the city of Baiyin and Yuzhong County, the project has a designed generating capacity of 300,000 kilowatts, capable of producing 1.46 billion kilowatt hours of electricity a year.

Sources said the construction was a clear indication that the government has started to put into action its much-publicized water development scheme on the second longest river in China.

So far this section of the river has seen five hydropower stations in operation while Lijiaxia, the sixth one, has been under construction since 1988.

On the government's blueprint, a total of 15 stations have been planned for the upper reaches of the river—13 million kilowatts in total designed generating capacity. Most are expected to start construction by the end of the century.

Designed to regulate the harmful river floods and improve the region's electricity supplies, these projects are "of vital importance to help get rid of the poverty along the river," said an official from the State Energy Investment Corporation.

The corporation, along with provincial investors, will jointly supply the funding, of the medium-sized project which it is estimated will cost 983 million yuan ($183 million).

Corporation sources said funding has been the sole factor holding up the building of the investment-intensive and time-consuming hydropower projects.

A million-kilowatt-capacity hydropower project costs anywhere between 300 and 400 million yuan and may take 10 to 12 years to complete.

The central government has been more interested in launching coal-based plants which cost less and are quicker to put into operation. Little overseas funding has been available so far.

But the work in hand has started to encourage diversified funding—meaning actually more local contributions—for water projects in places where coal is scarce.

The Daxia scheme, where costs are being shared between central and local investors, is "the latest successful case in point," a corporation official said.

He did not specify how the funding is shared between the two sides, but told CHINA DAILY that management and profits would be shared according to investment contributions.

He said the solution might be followed by other undertakings on the river.

It was also disclosed that preparations on half a dozen other projects now in the design stage, were expected to be intensified now that the construction at Daxia is in full swing.

The largest of the planned projects will be the Lawaxi hydropower station, near the famous Longyangxia project, completed in 1989 after 13 years.

Overseas Investment Said Vital To Ensure Energy Development Plans

40100074d Beijing CHINA DAILY (Economics and Business) in English 13 Aug 91 p 2

[Article by staff reporter Huang Xiang]

[Text] The government's leading energy investor in calling for more foriegn funding to help cover project construction in the 1990's.

Yao Zhenyan, president of the State Energy Investment Corporation (Seic) said that overseas funding is vital to ensure the nation's capital-intensive energy-development scheme.

The ministerial-level corporation is responsible for directing State investment in major electric and coal projects. It has also been active in the introduction of local investment and funding from outside China.

Yao said the State alone cannot afford the industry's ambitious expansion programme, resulting in the government's increasing dependence on "a diversified source of funding."

The energy sector is expected to need an increase of 30 million tons of coal and 10 million kilowatts in generating capacity a year up to 2000. But scarcity of funding is known to be a major hurdle towards achieving this goal.

China depends on foreign capital for 20 prcent of its total investment in energy projects. The rest is shared between the central government and local sources.

Foreign funding includes World Bank loans, and loans and grants from several governments.

The president said the introduction of foreign investment is especially important to the construction of hydropower stations, which are "extremely money and time-consuming compared with coal-based power plants."

It generally takes six to 12 years and may cost up to several hundred million yuan to build a large hydropower station—a factor which tends to put off foreign investment.

The industry plans to install 45 million kilowatts of water-powered generating capacity in the 1990's.

Yao said that the use of foreign money has proved to be effective, highlighted by the successful completion of South China's Lubuge station.

The Lubuge project, hailed as the nation's showcase hydropower development, was completed in June.

It was partially funded by World Bank loans and was the first project in China to use them. It was also the first time that a Chinese firm had undertaken a hydropower project through international bidding.

The station, costing 1.66 billion yuan ($313.2 million), is capable of producing 2.75 billion kilowatt hours of electricity a year.

Calling it a treasure-house, Yao said Chinese industries should learn valuable lessons from it in terms of the introduction of foreign funds, technology and management.

"Along with the World Bank loans came advanced methods, including better design, open bidding and a more efficient management system," Yao said.

The World Bank is also involved in the construction of the 10-billion-yuan ($1.9 billion) Ertan Hydro-electric power station, the nation's largest.

The project in Sichuan Province will have a total generating capacity of 3.3 million kilowatts, turning out 17 billion kilowatt hours of electricity a year.

Yao said the World Bank will provide 40 percent of the investment. Construction is now under way with the evaluation report approved and all technical negotiations and legal arrangements for the loan completed.

Preparatory Work on Ertan Now Completed

40100065B Beijing CHINA DAILY (Business Weekly) in English 8 Jul 91 p 4

[Text] Chengdu (Xinhua)—Work starts on building China's biggest hydro-electric power station, at Ertan, in Sichuan Province, soon.

Preparatory construction for the project has been completed after some four years' work by the Ertan Hydro-electric Development Corporation, according to Yao Zhenyan, general manager of the State Energy Investment Corporation.

The Ertan project, on the Yalongjiang River in Southern Sichuan, will have a total generating capacity of 3.3 million kilowatts. It will be China's first super-hydropower station, ranking ahead of the Gezhouba and Longyangxia stations, which currently are the biggest on the Yangtze and Yellow rivers. The Gezhouba power station has a generating capacity of 2.715 million kilowatts and Longyangxia has a capacity of 1.89 million kilowatts.

The main construction of the Ertan project will include a double curve arch dam with a maximum height of 240 metres, two spillway tunnels, an underground powerhouse and a man-made lake with a storage capacity of 5.8 billion cubic metres. The dam will be the third biggest in the world, only after the 272-metre Inguri dam, in the Soviet Union, and the 262-metre Vajoint dam, in Italy.

Annual electricity production will amount to 17 billion kilowatt hours, about half of the present electricity output in Sichuan. This will greatly alleviate the severe power shortage in China's most populous province.

Yao Zhenyan, general manager of the State Energy Investment Corporation, said the project would be the first step to tapping China's most abundant water energy resources, the Panxi area of Sichuan, where the Jinsha River and the upper reaches of the Yangtze River meet the Yalongjiang River. Available water energy resources here are estimated to amount to more than 10 percent of the national total. The area also boasts rich mineral deposits.

The Ertan dam will be one of 11 to be built to harness the region's potential water energy resources of nearly 25 million kilowatts.

Total investment at Ertan will be 10 billion yuan ($1.9 billion), 60 per cent of which will come from the central government and Sichuan Province, and the other 40 per cent from the World Bank.

Sun Zhongbi, general manager of the Ertan Hydro-electric Development Corporation, said that the World Bank had approved the evaluation report for the project, and all the technical negotiations and legal arrangements for the loan had been completed.

He said eight companies from Italy, France, Germany, Switzerland and China tendered for the construction of the dam and underground workshops two years ago.

The generating units and other equipment will also be purchased through international bidding.

As one of several super hydro-electric power stations, Ertan has worked out a high-quality bidding document after consultation with Harza Engineering Company International.

Ertan has made great efforts to improve the investment and construction environment in the past four years.

Hydropower Boost for Southwest Provinces

40100074c Beijing CHINA DAILY in English 6 Aug 91 p 1

[Text] Tens of billions of yuan are to be invested in turning the southwestern provinces of Sichuan, Guizhou and Yunnan into the country's largest hydropower production bases.

According to yesterday's PEOPLE'S DAILY, the government will channel the money into such major projects as the 3,300 megawatt Ertan Dam in Sichuan, which will cost 10 billion yuan ($1.9 billion). This, and other projects, will be launched during the Eighth 5-Year Plan (1991-95), boosting the country's hydropower output by 20,000 megawatts.

According to the PEOPLE'S DAILY, the new investment figure during the Eighth 5-Year Plan period is expected to be equal to that spent during the old "Third Line Construction Campaign" from 1965-75, when the central government invested about 170 billion yuan ($31.7 billion) in building more than 2,000 large- and medium-sized enterprises, called "Third Line projects". These were mainly in the fields of heavy and military-oriented industries.

Sichuan, Yunnan and Guizhou cover 1.1 million square kilometres—nearly 12 percent of the country—and feed more than 190 million people, or one sixth of the nation's total population.

According to the PEOPLE'S DAILY report, the second investment peak is the result of the central government's industrial policy change, which pays more attention to ecnomic development in Southwest China as well as South and East China.

Huge hydropower stations at Manwan, Yantan and Tianshengqiao, whose installed capacity exceeds 1,200 megawatts each, are well under way, with more than 10 large-scale hydropower stations to be started on the Yalongjiang and Jinshajiang rivers in Sichuan, the Lancangjiang in Yunnan and the Wujiang in Guizhou in the next 10 years.

By the end of this century, the Southwest China provinces will have a total installed capacity of 20 million kilowatts, bringing the areas to be the country's largest hydropower base.

The report added that in an attempt to divert more energy to economically developed regions in South and East China, workers are stepping up installation of a 1,000-kilometre-long ultra-high-voltage power transmission line which connects Tianshengqiao Hydropower Station with Foshan and Jiangmen in Guangdong, and is scheduled for completion by 1992. The installation of another power transmission line will be finished by 1997.

At the same time, the central government has been expanding the construction of the largest coal base in Guizhou Province, as well as rapidly developing the raw material processing industries in the three provinces.

More than 90 percent of the country's total estimated phosphorous ore deposits are to be found in Guizhou and Yunnan. Construction of China's largest phosphorous fertilizer and chemical industry production bases are well under way in the two provinces.

Major Conclusions on the New Appraisal of the Three Gorges Project Presented

916B0074A Beijing SHUILI FADIAN [WATER POWER] in Chinese No 5, 12 May 91 pp 6-16

[Article by Pan Jiazheng [3382 1367 6927], senior hydropower engineer in the Ministry of Energy Resources and vice chairman and chief technical official in the Chang Jiang Three Gorges Project Appraisal Leadership Group: "Major Conclusions from Reappraisal of Three Gorges Project"]

[Text] Editor's note: The grand scale and outstanding comprehensive benefits of the Chang Jiang Three Gorges key water conservancy project are world-renowned. Work to reappraise the Three Gorges project lasting over 2 years has now been completed. The recompiled feasibility research report has also been completed and submitted to higher authorities and the State Council has organized an examination committee to carry out an examination.

During the 4th Session of the 7th National People's Congress and the 4th Session of the 7th National People's Political Consultative Council, everyone was extremely concerned about the situation at the Three Gorges project and there were also reports in the news media. To enable readers to understand the appraisal situation for the Three Gorges project, comrade Pan Jiazheng, vice chairman and senior technical official of the Three Gorges Project Appraisal Leadership Group, has agreed to discuss the second part of his report information given at the Three Gorges Project Report Meeting convened by the State Council on 6 Jul 90, which published major conclusions from the Three Gorges project reappraisal. Some abridgements were made at the time of publication for reasons of space limitations.

I. The Three Gorges Project Construction Program Recommended by the Reappraisal

On the basis of the program approved in 1984 and the results of Three Gorges water level appraisals organized

by the State Planning Commission and State Science and Technology Commission in 1986, this reappraisal made a comprehensive economic and technical assessment of a total of six programs for normal water impoundment levels of 150 m, 160 m, 170 m, and 180 m, for two- stage development, and for " single-stage development, phased construction". It concluded by recommending a "single-stage development, one-time construction, phased water impoundment, and continuous resettlement" Three Gorges project construction program with a dam height of 185 m and one-time construction. The water level during initial operation would be 156 m, the eventual normal water impoundment level would be 175 m, and resettlement would be carried out in a continuous fashion and would be completed over 20 years.

The site of the large dam is Sandouping Town in Yichang County, Hubei Province, 40 kilometers from the Gezhouba key water conservancy facility already constructed downstream. The dam site would control a basin area covering 1 million km^2 with a perennial average yearly runoff of 451 billion m^3. The total reservoir capacity would be 39.3 billion m^3 which would include 22.15 billion m^3 in flood prevention capacity and 16.5 billion m^3 of beneficial reservoir capacity that would be jointly used for flood prevention. The reservoir backwater could improve about 600 kilometers of the river shipping channel. The hydropower station would have a total installed generating capacity of 17,680MW and generate 84 billion kWh of power annually. Calculated at price levels at the end of 1986 and including the cost of power transmission and transformation, the static investment would be 36.11 billion yuan, including an investment of 18.77 billion yuan for the key water conservancy project, 11.06 billion yuan in investments for population resettlement for the reservoir, and 6.28 billion yuan in investments for power transmission and transformation to supply power to east China, central China, and eastern Sichuan. The total construction schedule for the key project would be 18 years, including 3 years of preparations and 9 years from the time that construction of the main project begins until the first generator starts producing power. Resettlement of the population would be done on a continuous basis and completed over 20 years. Compared to the 150 m program for the Three Gorges project approved in principle by the State Council in 1984, this reappraisal carried out extensive research concerning several economic and technical issues and new suggestions. The proposed program is more reasonable and stable. The study exceeded the depth of the feasibility research stage in many areas. Compared to the 150 m program approved in 1984, this reappraisal raised the dam height from 175 m to 185 m and raised the normal water impoundment level from 150 m to an initial operation water level of 156 m and an eventual normal water impoundment level of 175 m. This change increased the normal flood prevention reservoir capacity from the original 7.3 billion m^3 to 22.15 billion m^3. It increased the flood prevention, power generation, and water-borne shipping benefits of the Three Gorges project and avoided the problem of temporary inundation due to major flooding in excess of impoundment levels. The project would first operate at a water level of 156 m and eventually be raised to 175 m. This would help in arranging for the resettled population and would aid in inspecting the effects of silt accumulation on harbors in the tailwater shipping channel of the reservoir.

During the appraisal, many experts suggested different project construction programs. Some used the perspectives for dam safety during wartime, population resettlement, and relative ease in dealing with silt changes in the tailwater region to propose a water impoundment level of 160 m. Some took reductions in silt accumulation at Chongqing and the size of the population to be resettled as the starting point to advocate two-stage development. Some used the perspective of aiding water-borne shipping to suggest a water impoundment level of 180 m. Some siltation experts took the effects of silt accumulation at Chongqing into consideration to advocate a water impoundment level of about 172 m. After discussions, most experts supported the program recommended above.

II. The Necessity of Building the Three Gorges Project

The geographic location of the Three Gorges project is such that the vast southwest China economic zone with its abundant products lies upstream while the central China and east China economic zones with their relatively prosperous economies lie downstream. The Three Gorges project would have huge comprehensive benefits for these regions in economic development and in promoting what is beneficial and abolishing what is harmful. The primary roles of the recommended program are: 1) It can control flood waters upstream on the Chang Jiang to avoid the danger of flooding over a vast region in the middle and upper reaches of the Chang Jiang and ensure economic construction and social development. 2) It would supply large amounts of electric power to central and east China and the eastern Sichuan region which could effectively alleviate the long-term energy resource shortage that these regions have been experiencing. 3) It would bring significant improvements to shipping channel conditions between Yichang and Chongqing and create the conditions for direct passage of 10,000-ton grade flotillas from Wuhan to Chongqing.

A. In the area of flood prevention:

A vast region is endangered by flooding on the Chang Jiang, and the region in the middle and lower reaches is subjected to the most severe and frequent threats. It is the key area for flood prevention on the entire Chang Jiang. Written records and surveys indicate that over the 2,000-year period from the Han Dynasty to the late Qing Dynasty, there were over 200 floods on the middle and lower reaches of the Chang Jiang, an average of one flood every 10 years. The peak flood flow rate at the Yichang station in 1788 reached 86,000 m^3/s. The Jingjiang dike was breached in 22 places and Jingzhou Town was

flooded, killing a large number of people. During two huge floods in 1860 and 1870, the maximum flow rates at Yichang station reached 92,500 m^3 and 105,000 m^3, respectively. The flow rate at Zhicheng, the control station on the Jingjiang section of the river, reached 110,000 m^3. Two holes were breached at Ouchi and Songzi on the south bank which caused devastation in the Dongting Hu region. Because the flood was so huge, the north bank was also breached downstream from Linli and the Jianghan Plain was inundated. Losses during these two floods were extremely serious. During this century, floods in 1931 and 1935 flooded 50.9 million mu and 22.64 million mu, respectively, on the plain in the middle and lower reaches and deaths amounted to 145,500 and 142,000, respectively. Hankou was inundated for 3 months in 1931. During a major flood in 1954, in a situation of reinforced dikes and major prevention and rescue efforts by large numbers of military and civilian personnel, the floodwater flow rate from floodwater diversion and overflowing dikes exceeded 100 billion m^3 and 47.55 million mu of farmland was inundated. The affected population reached 18.88 million people and 33,000 deaths were directly due to the disaster. The Jing-Guang [Beijing-Guangdong] railroad was unable to operate normally for 100 days.

In the 30-plus years since our nation was founded, the party and government have led the people in building large-scale flood prevention projects, raising and reinforcing over 30,000 kilometers of dikes in the middle and lower reaches, and completing 3 billion m^3 of earthworks. They have built the Jingjiang floodwater diversion, Dujiatai floodwater diversion, and other projects and arranged several floodwater diversion and impoundment areas. They have built several comprehensive utilization reservoirs on tributaries including Danjiangkou reservoir, which has enabled preliminary control of the threat of flooding on the middle and lower reaches of the Han Jiang, and others like Taixi on the Zi Shui, Zhelin on the Xiu Shui, Chencun on the Qingyi Jiang, and so on which play definite roles in flood prevention. These measures have brought initial changes to the situation of frequent disasters on the middle and lower reaches of the Chang Jiang. Based on the flood prevention program approved by the State Council in 1980 for the middle and lower reaches of the Chang Jiang, we are still continuing to build dikes and floodwater diversion and impoundment areas and expect to complete them in 1995. After these projects are completed, however, the dikes on the trunk in the middle and lower reaches still can only withstand floods that occur once every 10 to 20 years and the Jingjiang segment can only handle floodwater flow rates of 60,000 m^3, which is roughly equivalent to floods that occur once every 10 years. If these standards are exceeded, it will be necessary to employ floodwater diversion and impoundment measures. However, the floodwater diversion and impoundment areas are in regions that have already been developed. They have large amounts of farmland and dense populations, so diversion and impoundment of a single flood will cause enormous losses and it will be very hard to guarantee personal safety. Having paid the above price, the Jingjiang segment can still only handle a flow rate from Zhicheng no greater than 80,000 m^3, which is roughly equivalent to floods that occur once every 40 years. When this flow rate is exceeded, research done over many years indicates that unless the Three Gorges reservoir is built, there is no other feasible flood prevention method. Moreover, surveys of historical floods show that since the year 1153, the peak floodwater flow rate at Yichang has exceeded 80,000 m^3 on eight occasions and 90,000 m^3 on five occasions. During the two huge floods in 1860 and 1870, the flow rate at Zhicheng was about 110,000 m^3. If a flood like the one in 1870 occurs again, after the floodwater diversion and impoundment area is utilized, there will still be about 30,000 m^3 of excess floodwater flow rate that cannot be safely handled by the Jingjiang segment, which inevitably will cause breaching of the dike on the trunk. Flooding of a large area of farmland will occur, either through inundation of the Dongting Hu region to the south or inundation of the Jianghan Plain to the north, with disastrous damage from flooding in cities and large numbers of people injured and killed. An even greater possibility is total breaching both to the north and the south and inundation of both Hunan and Hubei. A breach of the large Jingjiang dike would also directly affect the safety of Wuhan City. The area to the south and north of Jingjiang are prime locations in Hunan and Hubei. Whenever a problem occurs, it affects the entire country and in particular it is impossible to avoid large numbers of people being killed. This is a major political question and a major peril to flood prevention on the Chang Jiang, and we must concentrate forces to solve it as quickly as possible.

B. The primary flood prevention roles of the recommended program for the Three Gorges reservoir are:

1. For the Jingjiang region, a flood which occurs once every 100 years or floods like those in 1931, 1935, and 1954 would not require utilization of the Jingjiang floodwater diversion region. For a flood which occurs once every 100-plus to every 1,000 years or flooding similar to that in 1870 (such flooding occurred on three occasions between 1788 and 1870, which was less than 100 years), it could control a maximum flow rate of 71,700 to 77,000 m^3 at Zhicheng which in conjunction with floodwater diversion at Jingjiang and other measures could guarantee the safety of both banks at Jingjiang.

2. For the region near Chenglingji, including the Dongting Hu and Hong Hu regions, a flood basically would require no floodwater diversion and it would greatly reduce the amount of floodwater diverted and impounded and inundation losses from flooding similar to that which occurred in 1931, 1935, and 1954.

3. For the Wuhan region, effective control of upstream floodwaters could prevent the threat to Wuhan from breaching of the big Jingjiang dikes and increase the

reliability and flexibility of flood prevention and dispatching operation for Wuhan City.

4. It would create the conditions for building control gates at Songzikou, Ouchikou, and other locations and reduce the threat to the Dongting Hu region from flooding on the trunk, and it would reduce siltation in Dongting Hu and slow the silting up and extinction of Dongting Hu. In the long-term perspective, it could replace part of the functions of Dongting Hu.

During the discussions, conscientious study was done concerning the doubts and varying opinions suggested by some comrades, such as the flood prevention role of the Three Gorges reservoir for the middle and lower reaches and Wuhan City, research on substitute flood prevention programs for the middle and lower reaches that would not require construction of the Three Gorges project, whether or not the Three Gorges project would increase the threat of flooding in Sichuan Province and force families to move because of the danger of flooding, and so on. After repeated research, if the Three Gorges project is not built and we can only use completion of the 1980 program in the short term as a foundation for additional reinforcement of the dikes in the middle reaches, build additional flood diversion and control projects in each of the floodwater diversion and impoundment areas, and increase floodwater diversion and impoundment safety measures, they could operate in the long term in conjunction with reservoirs on the trunk and tributaries in the upper reaches. This program would require an estimated investment of about 7 billion yuan. The probability of utilizing floodwater diversion and impoundment would be about the same as it is now. In the event of a flood that occurs once every 100 years or less, there would be some improvements in the safety of floodwater diversion and impoundment and floodwater passage by the river channel, but there would be huge losses from the floodwater diversion and impoundment and no obvious improvement in the situation of temporary population movement and flood prevention problems. This is particularly true for floods that occur once every 100-plus years and in the event of a major flood like those in 1788, 1860, and 1870. It would still be impossible to avoid destructive disasters and the serious risk on the Jingjiang segment would persist.

C. From the perspective of energy resources:

The Three Gorges hydropower station would have an installed generating capacity of 17,680MW and generate 84 billion kWh of power annually. It would mainly supply central and east China and a portion would be transmitted to eastern Sichuan. It could replace 40 to 50 million tons of raw coal a year. It would be equivalent to ten Daya Bay nuclear power plants or seven 2,400MW thermal power plants, one coal mine producing 50 million tons annually, and the corresponding coal haulage railroad. Compared to thermal power, it could reduce discharges of CO_2 by over 100 million tons, SO_2 by 2 million tons, CO by 10,000 tons, NO_x by 370,000 tons, and a substantial amount of residues and waste water, which would help reduce environmental pollution.

Industrial and agricultural production in the central and east China regions is developed but energy resource shortages for the past several years have restricted economic development. These two regions have very limited coal resources, just 3.6 percent and 3.2 percent, respectively, of China's total. At present, they must ship in coal from north China. Several thermal power generators were forced to shut down in the east China region during 1989 because of the coal shortage, so further development of thermal power is restricted by coal production and especially by transportation. There were not very substantial hydropower resources in the east China region to begin with and most of those with superior conditions have already been developed. In the future, they will mainly develop medium-sized and small hydropower and pumped-storage power stations. Some 70 percent of the central China region's remaining hydropower resources are concentrated on the Three Gorges river segment. According to electric power development plans for the two regions, from 1986 to 2015, they will have to increase power output by 860 billion kWh and the installed generating capacity by 170,000MW, meaning that even if the Three Gorges project and other hydropower stations are built they will still have to add 130,000MW in thermal power and ship in 285 million tons of raw coal annually from the north China energy resource base area. There are still major problems with coal production and transport that must be resolved. If we abandon the Three Gorges project and replace it with thermal power plants, this will exacerbate the coal production and transportation difficulties and pollution problems. From the perspective of rational energy resource deployments, this is unexplainable.

Some comrades have proposed that hydropower stations be built at Xiluodu and Xiangjiaba on the Jinsha Jiang, on the Wu Jiang, and on other tributaries as replacements for the Three Gorges project to transmit power to the central China and east China regions. According to the 1986-2015 electric power development plan for the central China, east China, and southwest China regions, there will be a major effort over this 30-year period on building thermal power and nuclear power and continued development of hydropower stations at the Three Gorges project and on the Jinsha Jiang, Yarlong Jiang, Dadu He, Min Jiang, Jialing Jiang, Wu Jiang, Qing Jiang, Han Jiang and on the Dongting, Poyang, and other water systems. Among them, we will have to begin construction of Xiluodu and Xiangjiaba on the Jinsha Jiang and place a part of them into operation, so there is no question of mutual substitution here. In terms of preparatory work that has already been done, geographic locations, and regional load requirements, arrangements for the Three Gorges should be placed ahead of Xiluodu and Xiangjiaba. Electric power system experts have made analytical calculations which combined four comparative programs for power stations on the Jinsha

Jiang, Wujiang, and tributaries in the central China region. Their conclusion was that, in economic terms, it was better to include the Three Gorges project and build the Three Gorges project first. The southwest China region has few coal resources and should accelerate local development of hydropower stations on the tributaries of the Chang Jiang, but this could only satisfy local power use requirements. Jinsha Jiang hydropower could be transmitted to east China and consideration should be given to transmitting it to east China. In the short-term, however, it is most realistic to use the Three Gorges project to solve the power shortages in central and east China.

D. From the perspective of communication and transportation:

The southwest China economic zone in the upper reaches of the Chang Jiang centered on Chongqing has abundant resources and substantial development potential, but communication is inconvenient, so developing transportation is a key measure for development in southwest China. The trunk of the Chang Jiang cutting across it from east to west is a major transportation artery and the annual freight volume downstream on the river is expected to reach 50 million tons by 2030. At present, however, the downstream freight volume is only about 10 million tons and is mainly restricted by the current state of the shipping channel. The river shipping channel flows through high mountain gorges with fierce currents and densely distributed hidden shoals. The conditions are poor on the 600 kilometer-long shipping channel from Chongqing to Yichang and there are a total of 139 hidden shoals along its course which hinder shipping as well as 46 single-passage control segments which severely obstruct development of water-borne shipping. The Three Gorges reservoir could submerge these hidden shoals on the river and make significant improvements to conditions on the shipping channel, allowing 10,000-ton flotillas to sail directly to Jiulongpo at Chongqing during half the year. In conjunction with harbor construction and vessel modernization, the yearly downstream freight capacity could be increased to 50 million tons and shipping costs could also be reduced by 35 to 37 percent. Research by a group of shipping experts indicates that if we do not build the Three Gorges project but instead adopt large-scale shipping channel improvements in conjunction with distribution onto railroads running out of Sichuan, although it would also be possible to increase the freight volume out of Sichuan to 50 million tons, there would be no basic improvement in the current conditions on the river and it would be unable to satisfy the need for direct passage of 10,000- ton flotillas between Wuhan and Chongqing.

Besides the enormous benefits in flood prevention, power generation, shipping, and other areas, the Three Gorges project could also increase the flow rate during the dry season in the middle and lower reaches of the Chang Jiang, which would create the conditions for improving shipping conditions in the middle and lower reaches and for transmitting water from south to north China. It is a key water conservancy project that would have enormous overall benefits and is of irreplaceable strategic significance for economic development in the central China, east China, and southwest China regions.

III. Technical Feasibility

The basic information concerning the Three Gorges project is complete and reliable. There is a long series of highly precise hydrological and siltation data for the Chang Jiang. Geological and topographical measurement and prospecting work has been done on a continuous basis for over 30 years and there has been extensive and detailed data collection, processing, analysis, and research work. This reappraisal again carried out comprehensive checking and supplemented it with a large amount of scientific research and survey work on several major technical issues including basic data, structural design and construction, manufacturing and installation of the primary electromechanical equipment, reservoir-induced earthquakes, reservoir bank stability, silt accumulation, civil defense, and so on. The conclusion of the appraisal was that the basic data for the Three Gorges project was complete and reliable, preparatory work for the project was relatively complete, and it had a rather solid foundation in planning, surveying, designing, and scientific experimental research achievements. The technical problems that would have to be resolved during project construction included several doubtful problems that were suggested over the past several years. The relevant experts have drawn clear conclusions for all of them, there are no insurmountable technical barriers, and construction of the Three Gorges project is technically feasible.

Although the scale of the Three Gorges project is very large, the big dam is a concrete gravity dam with a maximum height of 175 m and is located on an integral granite rock body. The configuration of the key facilities is simple and, with the exception of a small amount of primary electromechanical equipment that would have to be imported or manufactured cooperatively, most could be provided by domestic sources. For the structures, with the exception of cascade boat locks and boat lifting equipment which exceed current international levels, the remaining engineering would mainly involve rather large scales, none of which would exceed levels in projects already built in China and foreign countries in terms of technical properties. China's experience in water conservancy and hydropower construction over the past 40 years shows that we are entirely capable of completing the design and construction tasks. There is no disagreement over this. What worries people in various circles is silt accumulation, reservoir-induced earthquakes, reservoir bank stability, and other questions.

A. On the question of siltation

The average annual runoff at the Three Gorges dam site is 451 billion m^3, the annual amount of silt transported is 530 million tons, and the yearly average silt content is

about 1.2 kg/m^3. Compared to the Huang He, the average yearly runoff at Sanmen Gorge is 42 billion m^3, the annual amount of silt transported is 1.6 billion tons, and the yearly average silt content is 37.9 kg/m^3. The absolute value for the annual amount of silt transported on the Chang Jiang is still rather large, however, and it is an important shipping route, so the silt question must be handled carefully. To assess the siltation question, 36 of the best and most experienced siltation experts in China were recruited to form a siltation experts group which can be said to have collected the cream of the siltation profession in China.

The main questions regarding siltation in the Three Gorges project are: Would the reservoir become silted up very quickly and lose its role? In the backwater region that is changed, would silt accumulation affect the shipping channel and harbor areas, and would Chongqing Harbor become a dead harbor? What affects would long-term silt accumulation have on Chongqing City's flood prevention water levels? And so on. In this assessment, many previous research achievements served as a foundation and the siltation experts group also arranged for a substantial amount of supplementary surveys, calculations, and experiments. After repeated discussion and study, they proposed that the entire experts group sign and accept the topical assessment report and they drew unanimous conclusions concerning the previous questions.

Regarding the reservoir lifespan question, because the Three Gorges reservoir would be a narrow and long river channel-type reservoir and because the amount of silt transported in the Chang Jiang is concentrated during periods of flooding, theoretical research and practical experiments indicate that the Three Gorges reservoir could adopt a "impounding clean and discharging murky" operational pattern. During the flood season, the reservoir water level would be lowered to the "flood prevention limit water level" that could make room for flood prevention reservoir capacity and at the same time the floodwater flow rate could be sent through bottom holes to discharge a large amount of silt. Most of the reservoir would be effective reservoir capacity and could be retained for a long period. Based on this operating pattern, for a substantial period of time after the reservoir is built, the amount of silt entering the reservoir would be greater than the amount being discharged, so there would be silt accumulation within the reservoir and the locations of the siltation would be mainly in the dead reservoir capacity and several side shoal and reservoir tail sections. After several decades to a century of operation, the amount of silt entering and exiting would basically be balanced (flushing-accumulation equilibrium) and the Three Gorges reservoir would still be able to maintain 85 percent of its flood prevention reservoir capacity and 92 percent of its beneficial capacity, so it could function for a long time.

As for the question of the effects of silt on the shipping channel and harbors, the reservoir region could be divided into two main parts, a "year- round backwater region" and a "variable backwater region". Dangerous shoals in the year-round backwater region reservoir section at the Three Gorges reservoir would be submerged all year and there would be significant improvements in the shipping channel. There would also be improvements to varying extents in the shipping channel in the variable backwater region but during dry years after several decades of operation at the facility and during the later periods of reservoir water level reductions, obstructions to shipping and affects on harbor area operations would appear in the shipping channel and harbor areas on certain sections of the river. Optimized reservoir dispatching in conjunction with harbor upgrading and appropriate shipping channel improvement measures could solve these problems. Experiments indicate that there would be a basic equilibrium in silt flushing and accumulation during the year in the shipping channel and that the scale of the improvement projects would not be large. Accumulative silting would occur on the side shoals in Chongqing Harbor, which could be dealt with by adopting improvement projects on a substantial scale. The actual improvement program could be selected through experimental research in the next step.

A report has already been provided concerning the question of the effects of reservoir tail silt accumulation on water levels in Chongqing City. Moreover, silting problems in the dam area will occur several decades after the project has been in operation and experience at Gezhouba indicates that they can be dealt with by adopting measures in phases. The silt experts feel that operation of the Three Gorges project would have not significant effects on the area at the mouth of the river, but there are different views in the ecology and environmental experts group. A report on this question has already been provided in the ecology and environmental study.

Regarding the silt data employed in the appraisal, some experts in the flood prevention experts group felt that because of the effects of human activity, there would be continually growing amounts of silt entering the Chang Jiang, with an average annual silt transport amount of slightly less than 530 million tons. The hydrology experts group analyzed variational trends in the silt situation on the trunk of the Chang Jiang above the Three Gorges and feel that there is no obvious trend toward growing amounts of suspended silt. The appraisal leadership group assigned professor Yan Kai [0917 1956] to chair a special discussion to which 48 relevant experts were invited in 1988. The preferred view at the discussion meeting was that human activity had certainly exacerbated soil erosion in the upper reaches of the Chang Jiang, which required stronger soil conservation work. However, the amount of silt in the trunk of the Chang Jiang had still continued to fluctuate around the perennial value for years and there was no significant trend toward increasing. Thus, the 530 million ton figure based on analysis of actual measured silt data over more than 30 years could be used for the amount of silt arriving in

the Three Gorges design. To allow some leeway, the silt experts did some sensitivity analysis computations using a 30 percent increase in the amount of silt arriving when they were calculating the effects of silt accumulation on rising floodwater levels in Chongqing City. The conclusion was that there was no real effect on silt accumulation from long-term operation of the reservoir.

B. On the question of geology and earthquakes

The geology and earthquake experts group was composed of 24 experts including seven people from the hydropower system and one person from the Ministry of Communications, with the remaining people being geology experts from the Chinese Academy of Sciences, Ministry of Geology and Mineral Resources, State Earthquake Bureau, and institutions of higher education in geology.

The question of geology and earthquakes at the Three Gorges project has been studied for 30-plus years beginning in 1955. The amount of material work and survey and research work completed was seldom seen in a project's history. During this appraisal, the experts group dealt with questions of concern in society and made supplementary arrangements for prospecting and survey work by several hundred geology experts. They did repeated research and drew entirely identical conclusions. The overall assessment of the experts group concerning the geological conditions in the region of the dam site was that the dam site bedrock was integral and had high dynamic strength, weak permeability, and superior engineering geology conditions, and was suitable for the construction of a tall concrete dam.

As for the question of reservoir-induced earthquakes, the experts group felt that although current scientific and technical levels do not permit precise forecasts of them, based on the geological structural background of the reservoir region, the scale and distribution of the primary fractures, and consideration of the historical earthquake situation, it is entirely possible to make qualitative and quantitative diagnoses of earthquakes that might occur after the reservoir is built and the scale of reservoir-induced earthquakes. As for its geological structure, the Three Gorges project is in a relatively stable region with a low level of seismic activity and a weak earthquake environment. The intensity of earthquakes in the dam area is determined by the effects of earthquakes in the surrounding region. Several inspections by state earthquake departments indicate that setting the basic intensity at magnitude 6 is reasonable. Although the possibility of reservoir-induced earthquakes in local areas after the reservoir is built cannot be eliminated, there is little possibility of generating rather powerful reservoir-induced earthquakes. The high estimate is that the intensity of the effects of reservoir-induced earthquakes on the dam area would not exceed magnitude 6, which is smaller than the resistance to magnitude 7 earthquakes in the design, so they would not affect project safety.

As for the question of bank stability in the Three Gorges reservoir, several units did parallel surveys and research during this reappraisal and drew basically identical conclusions. The banks of the Three Gorges reservoir are mainly composed of hard rock and the overall stability conditions are rather good. According to parallel surveys, computations, experiments, and monitoring by several departments, there were large and medium-sized landslides and blockslides larger than 1 million m^3 in about 140 locations on the banks of reservoirs on the trunk of the river. Deformation developed at 8 locations and there is rather poor stability at 14 sites, but all were more than 26 kilometers from the dam site. Surge calculations and experiments were done based on assumptions of the most unfavorable conditions in which new landslips occur in the shoals nearest the dam and entire chains of dangerous cliff rock bodies slip into the river. The surge this would create would be attenuated when it reached the dam site and the maximum wave height created would be about 2.7 m, which would not affect the safety of the large dam. After water is impounded in the reservoir, the threat of obstructions to shipping caused by landslides and landslips would be reduced compared to natural conditions. After Gezhouba was completed, large landslips of new shoals in 1985 did not obstruct shipping, which is an example.

IV. The Question of Population Resettlement for the Reservoir

Whether or not arrangements can be made to resettle the population in the reservoir region is the key and most difficult problem in construction of the Three Gorges project. Central authorities and local areas are both extremely concerned and foreign countries are also concerned with this issue. The reappraisal made full use of the great deal of work and achievements of the Chang Jiang Basin Office, Hubei Province, and Sichuan Province, by hydropower departments and construction departments in the relevant prefectures, cities, and counties, the Chinese Academy of Sciences, and by soil conservation, ecology, national territory, civilian government, aquaculture, historical relic, geology, cartography, and other departments. On the basis of work by a reservoir inundation and population resettlement experts group organized by the State Planning Commission and State Science and Technology Commission when they were assessing water levels, governments at all levels centralized over 400 technical personnel and resettlement cadres who joined with over 1,000 comrades and did repeated research before completion.

For inundation indices for the Three Gorges reservoir at elevations below 160 m, after a statistical survey of every village and every household and reexamination by all counties (cities), the precision was rather high. For 160 to 175 m, after calculations using data from previous surveys and reexamination by sampling, the data basically fit. The entire reservoir would inundate 357,000 mu of cultivated land (including about 110,000 mu of rice paddy) and 74,000 mu of orchards. According to statistics, the population of the inundated region in 1985

was 726,000 people, including a rural population of about 330,000, equal to 46 percent of the population to be resettled due to inundation. Taking into consideration natural population growth and various other factors that may cause the population to grow, calculations indicate that arrangements in resettlement plans would involve a total of 1.132 million people.

Given the problems left over from previous resettlement for reservoirs, the former Ministry of Water Resources and Electric Power convened a special reservoir population resettlement policy conference in 1984 to summarize experiences and lessons. To deal with past problems like low compensation standards, the absence of unified planning, dealing simply with grain production without solving the problem of grain rations, and so on, the principle of developmental resettlement was proposed. Two basic requirements were set forth for resettlement for the Three Gorges: 1) The production levels and living standards of the population after it had been moved must not be lower than levels prior to moving; 2) Development of population and life after moving must not be lower than average development levels of residents who had not been moved, and there must be unified plans for economic benefits, social benefits, and environmental protection. All standards must seek truth from facts and all arrangements must be adapted to local conditions. After joint study and repeated discussion by the experts group and local comrades, nine reform and policy proposals were suggested and the state was asked to approve them to serve as a set of matching measures for dealing with the resettlement problems of the Three Gorges. The main aspects were: 1) Establishing an ideology of total responsibility and formulating good annual plans for resettlement projects in which investments are allocated each year according to the plans after receiving approval from the state. Prior arrangements must be made for basic urban facilities, arrangements for base area construction for the resettled rural population, and intellectual development to prevent the implementation of continued construction in the flooded region to benefit the principle of developmental resettlement. 2) Implementing a policy which links the reservoir region with project benefits. Part of the taxes from the power station retained by the local area should be rationally allocated to Sichuan and Hubei Provinces, and after the first generator goes into operation and generates power, 0.003 yuan per kWh should be deducted as a reservoir area construction fund and used for construction in the reservoir region. Moreover, the counties in the reservoir area that are flooded should be included as rural poverty support counties and electrification counties and provided with support. 3) Implement a guaranteed grain ration policy and provide subsidies to those whose per capita amounts of available grain are lower than average local levels due to resettlement as a result of readjustments to agricultural production and crops, guarantee their grain rations, and avoid unreasonable reclamation to aid in environmental protection and prevent soil erosion. In addition, there are also reservoir region taxation policies, reservoir region foreign trade and foreign exchange earning listings, reform of the resettlement administration system, rational readjustments of contractual responsibility of the masses for land, barren mountains, and grassy hills in the resettlement arrangement area, and other policy proposals.

The results of the appraisal by the expert group and local cadres indicate that within a narrow zone about 2,000 km long along both banks of the reservoir area where the population will be dispersed in the Three Gorges reservoir region, there will be 331 townships in 19 counties (cities) that are concerned and none of the townships will be completely submerged. The cultivated land that is inundated will account for 0.15 percent to 5.88 percent of the cultivated land in each county and the population of submerged villages will account for 0.5 percent to 4 percent of the agricultural population of each county. The results of the program are that the resettled rural population will have sufficient useable land, arrangements can be made for 301 townships of the 331 flooded townships without going outside of the townships and 30 townships will require arrangements in nearby townships. The preliminary plan calls for a total of 361 townships in the arrangement area. Interpretation and checking of aerial photographs indicates that there are 1.23 million mu of barren mountains and grassy hillsides that could be reclaimed and that of this amount 292,000 mu of wasteland with better conditions could be selected for development into horizontal terraced land to develop citrus and other cash crops. Moreover, 125,600 mu of low-yield hillside cultivated land could be upgraded to build a high and stable output grain production base area. These two items could provide arrangements for 53 percent of the resettled rural population. The remaining portion could utilize the reservoir surface and grasslands resources to develop fishery and animal husbandry, and they could use natural resources and special local product advantages to develop township and town enterprises as well as secondary and tertiary industries. The experts group and local residents were unanimous in their view that adopting these arrangements and proportions for the resettled rural population is realistic and that there is adequate environmental capacity for the resettled rural population.

The Three Gorges reservoir would require moving or backing up 13 cities and 140 towns, and site selection and planning work has been done in accordance with state regulations for all of them. New plans for all the cities have sufficient leeway for development and there are substantial or fundamental improvements in the environmental conditions compared to existing ones. For the plants that would have to be moved, intention-type plans have been proposed which embody the principles of construction first and moving later, combining development of production with arrangements for the resettled population, adaptation to local conditions, and differential treatment. The resettled urban population would account for 54 percent of the population resettled for the reservoir region, and they would basically require no renewed arrangements for employment. The experts

group and local areas repeatedly studied all moving and construction compensation standards. Based on 1986 prices, calculations were made for each item involved in arrangements for the resettled rural population, city and plant moving and construction, compensation for moving and construction of public facilities in the inundated region, moving and excavating cultural relics and historical sites, reservoir bottom clearing, and other expenses, for a total of 11.061 billion yuan.

After strict examination of the population resettlement plan for the Three Gorges reservoir by foreign experts and world-class population resettlement experts, their assessment was that it was at high levels and of high quality. The resettlement assessment conscientiously absorbed the experiences and lessons from previous resettlements, gave consideration to the partial and the total situations, combined short-term and long-term views, stressed protection and improvement of the ecological environment, applied modern scientific and technical measures, and worked in cooperation with foreign countries to conduct typical trial points for the plan. The State Council's Three Gorges Regional Economic Development Office met with Sichuan and Hubei Provinces and the relevant prefectures, counties, and cities to organize developmental resettlement trial work that has been going on for more than 5 years now. They gained experience in making arrangements for the resettled rural population, moving cities and plants, personnel training, and other areas and were welcomed and supported by leading cadres and the masses in the reservoir region.

V. The Question of the Ecological Environment

The experts group did comprehensive analysis and research concerning the large number of research achievements of all units, in particular the Chinese Academy of Sciences and the Chang Jiang Water Resources Protection Bureau. They inspected the reservoir region, convened several meetings of experts, held repeated discussions and consultations, and eventually submitted an assessment report. The report treated the Chang Jiang basin as a large integral system, made comprehensive assessments of the changes in the structure and function of the ecosystem and the overall effects that would result from construction of the Three Gorges project, focused on clarifying ecological and environmental problems that would arise from population resettlement in the reservoir region, and suggested countermeasures and opinions. The assessment report concluded that the Three Gorges project would have widespread and profound effects on the ecological environment.

1. The beneficial effects of the large dam on the ecology and environment would mainly be in the middle reaches. The reservoir would effectively reduce severe ecological and environmental destruction in the plains lake region, a densely populated and economically developed area in the middle reaches, from flooding on the Chang Jiang as well as the psychological threat of flooding for people. It would aid in prevention of schistosomiasis in the middle and lower reaches. Compared to thermal power, the hydropower could reduce environmental pollution in the surrounding area and it could improve the local climate, reduce silting in Dongting Hu, and effectively regulate flow rates on the Chang Jiang.

2. The negative effects of the large dam on the ecology and environment would mainly be in the reservoir region. These negative effects can be divided into several categories according to their quality and degree: 1) Irreversible effects: some cultural relics and historical sites as well as the natural scenery of the Three Gorges and some cultivated land would be inundated after the reservoir impounds water. 2) Severe or rather large effects, but effects which can be reduced by adopting measures: ecological and environmental problems caused by reservoir inundation, moving and construction of cities, and the resettlement process; effects on the Chinese river dolphin and other valuable and rare species resources; effects on the threat of flooding and waterlogging in the reservoir tail area in the upper reaches; landslips, induced earthquakes, and other problems. 3) Relatively limited effects where the danger can be reduced by adopting effective measures: effects on the local climate and hydrological factors; effects on the health of the masses; effects on terrestrial animals and plants, and so on. As for effects on water pollution, although they are not serious at present, if the present situation of waste water being discharged into the Chang Jiang untreated continues, there will be a latent threat of pollution of the Chang Jiang.

3. Latent effects or those which are hard to project and quantify at the present time: long-term effects on aquatic organisms in the upper reaches; long-term effects on the region's natural ecology and socioeconomic system; effects on the ecology and environment at the mouth of the river and adjacent area, and other problems.

The assessment report stressed that of the many factors affecting the ecology and environment from the Three Gorges project, the environmental capacity for population resettlement in the reservoir area is a rather sensitive restricting factor in decisions concerning the project. It must be dealt with conscientiously and carefully. In addition, it suggested valuable opinions concerning present project assessment, decision making, and planning, the main content being:

1) With the objective of establishing and protecting an excellent ecological environment in the reservoir region and on the basis of scientific analysis of the environmental capacity in the reservoir region, we must prepare good population resettlement arrangement plans. The resettlement experts group has already done a great deal of work on this.

2) Soil erosion in the Chang Jiang basin is the main factor behind degradation of ecological conditions. We must begin now in focusing on planning, establish complete staffs, formulate effective policies and measures,

and do good water and soil conservation work in the reservoir region and upper reaches. Based on this suggestion, the appraisal leadership group entrusted the National Water and Soil Conservation Work Coordination Group with holding discussions to suggest measures. Its report received approval from the State Council in April 1988 and is now being deployed for implementation by the newly-established Upper Chang Jiang Water and Soil Conservation Commission.

3) Demarcate a specific area as a natural protection zone and national park, focus on protecting nature and historical heritages, move major cultural relics that will be submerged after the dam is built.

4) Implementation of developmental resettlement will lead to more development of industry and rural enterprises in the reservoir region, so we should reinforce environmental management and prevent increased pollution.

5) The reservoir design and dispatching should give full consideration to ecological and environmental needs. For example, reservoir dispatching should give full consideration to the rising water process and water temperature requirements for the breeding of the four main fish families, strive to reduce siltation in the reservoir region, and so on.

6) For several issues where there is still disagreement or which will take a long time to understand fully, more extensive work is needed to enable the drawing of clear conclusions.

Considering the difference of opinion within the ecological and environmental experts group concerning the effects of the Three Gorges project on the plains lake region in the middle reaches and the mouth of the river, the appraisal leadership group entrusted Water Conservancy Society director professor Yan Kai with chairing the "Conference To Discuss the Effects of the Three Gorges Project on the Plains Lake Region" and the "Conference To Discuss the Effects of the Three Gorges Project on the Mouth of the River" held in August 1988. The number of delegates participating were 32 and 30, respectively, and included experts covering the full range of views.

Regarding the effects of the Three Gorges on the plains lake region, several comrades felt that after the Three Gorges project is built, changes will occur in water levels in the Chang Jiang and in groundwater levels, and they are afraid that they could create or intensify the threat of conversion to swampland or waterlogging in the Four Lakes region north of Jingjiang in the middle reaches. After the meeting, it was felt that building a matching drainage and irrigation system in the Four Lakes region after the nation was founded had played an enormous role in increasing agricultural output, but substantial population growth and irrational development and utilization of land resources, even the enclosure of lakes to create farmland, had damaged the environment and caused soil gleysolization on some of the farmland. Whether the Three Gorges project is built or not, further improvement of the drainage system is necessary to lower groundwater levels to develop the farmland in the direction of reduced swampland and gleysolization. After the Three Gorges reservoir is built, the discharge flow rate during the October water impoundment period will be reduced, which would benefit natural drainage in this region. The discharge flow rate from January to May would be slightly greater than the natural flow rate and there would be a corresponding 0.2 to 0.23 m rise in the water level. Due to downward cutting in the riverbed, however, the actual water level would be somewhat lower. The delegates felt that construction of the Three Gorges reservoir would not increase soil gleysolization and conversion to swampland in the Four Lakes region, but some comrades felt that additional research was needed concerning the effects of higher water levels in the Chang Jiang during the dry season. All of them felt, however, that they could be solved through ideological attention, effective measures, and comprehensive prevention.

As for the effects of the Three Gorges on the mouth of the river, the siltation experts group felt that there would be no significant effects, but some comrades among the ecology and environmental experts were concerned that, after the Three Gorges reservoir is built, changes in water levels and silt content might affect salinization, silt erosion and accumulation, and saline tidal intrusion in the river mouth region. After discussion at the meeting, it was felt that after the Three Gorges reservoir is built, an increased water discharge rate from January to April would not substantially raise water levels at the mouth of the river, just 5 to 15 cm or so, and would not cause changes in overall groundwater level and soil gleysolization trends in the region. Concerning the question of siltation, the general feeling was that after the reservoir is built, silt will accumulate within the reservoir for a considerable period of time and the amount of silt discharged downstream would be reduced. However, silt smaller than 0.01 mm basically would not accumulate within the reservoir and would be replenished in the lower reaches, so there would be no major changes in the amount of silt arriving at the mouth of the Chang Jiang. Changes may occur in the erosion and accumulation process on local shoals and banks, and their effects should be studied and measures formulated. Some delegates still felt that a reduction in the amount of silt arriving at the mouth of the river may cause beach erosion. The conference felt that from the perspective of current research, the effects of soil gleysolization, silt accumulation, and so on at the mouth of the river were not restricting factors that would affect the decisions made, but scientific research and monitoring still should be strengthened to suggest reliable prevention measures for the negative effects.

Besides reservoir inundation, the other basic factors that would affect the ecology and environment are changes in hydrological and hydraulic conditions due to dam construction. The Three Gorges reservoir is a typical river

channel reservoir. It would be over 600 kilometers long and have an average width of 1.1 kilometer, which is only double the width of the natural river channel and about the same as the width of the river channel on the section at Wuhan. The reservoir capacity coefficient (ratio of the total reservoir capacity to annual amount of water at the dam site) is very small, just 0.09, whereas this coefficient is 2 for the Aswan reservoir in Egypt and China's Xin'anjiang reservoir, 0.55 for the Danjiangkou reservoir, and 0.39 for Sanmen Gorge. Thus, the Three Gorges reservoir would have limited effects on regulation of the natural runoff in the river. The average monthly discharge flow rate from the reservoir would be different from natural conditions only during the dry season and would fluctuate within the range of variation in natural flow rates. Full consideration and conscientious treatment should be given to the effects of the Three Gorges project on the ecology and environment and to countermeasures, but they should not become factors which restrict the decision concerning the Three Gorges project.

VI. Economic Rationality

The total amount of engineering for the key water conservancy facilities at the Three Gorges project would be 87.89 million m^3 of earth and rock excavation, 31.24 million m^3 of rock and earth fill, and pouring 26.89 million m^3 of concrete. The amount of civil engineering would be equivalent to the key water conservancy facilities at Gezhouba. It would have an installed generating capacity of 17,680MW and require the resettlement of 1.132 million people. There would also be the corresponding power transmission and transformation projects. The static cost of the project based on prices at the end of 1986 has been calculated at 36.11 billion yuan. If the interest on loans that would have to be paid during the construction period is included, the corresponding dynamic investment would be 45.2 billion yuan. The reliability of the project investment depends on the reliability of the basic design data and the accuracy of the design engineering. The hydrological and geological conditions of the Three Gorges project have been studied for years and repeatedly re-examined. The basic information is reliable. The project design has been going on for years and overall has already attained the depth of a preliminary design. There is no possibility of major omissions. The number of people to be resettled and the arrangement program for them has been checked throughout several times and is practical. The amount of engineering for power transmission and transformation has already been repeatedly compared and checked. The overall amount of engineering is reliable and a reserve fund of nearly 10 percent has also been left. Thus, the basis for calculating the investment is reliable.

On this foundation, the comprehensive economic assessment experts group used several methods for analysis and comparison. The conclusions they drew were that the Three Gorges project has superior economic properties, it would be better to build it than not to build it, and it would be better to build it sooner than later. Using the amount of material engineering for hydropower stations, the indices for the Three Gorges project are relatively low. Using the unit investment per kW for a hydropower station, the Three Gorges project is also relatively low. Compared with coal-fired power and nuclear power, the investment per kW to build new coal-fired power plants in central and east China, including the corresponding investments in coal mines and railroads (calculated for 600MW generators) would be 2,467 and 2,780 yuan, respectively. Compared to nuclear power, the investment per kW for Daya Bay power plant is about 6,000 yuan, while the figure for the Three Gorges project is 2,042 yuan. This is less than nuclear power and coal-fired power, and the latter do not provide flood prevention and water-borne shipping benefits, either.

The Three Gorges project is a project with a well-endowed geographic location and enormous comprehensive benefits. Repeated research by all of the relevant experts groups indicates that no other project could be substituted to play its role. In the area of flood prevention, no realistic and feasible program was found with the same or nearly the same benefits. Calculating based on dividing up the 36.11 billion yuan cost of the Three Gorges project, over 6 billion yuan would be allocated to flood prevention. Several envisaged substitute programs were described previously, but none could provide equal benefits and they would cost more, so they are not realistic. In the area of shipping, about 1.2 billion yuan of the investment for the Three Gorges would be allocated to water-borne shipping. The other program envisaged, which would involve improving the river shipping channel supplemented with distribution via railroad would cost nearly 4 billion yuan and would not be able to achieve the objective of direct passage of 10,000-ton flotillas from Wuhan to Chongqing. Three substitute programs were prepared in the area of power generation. Nearly 30 billion yuan of the cost of the Three Gorges would go for power generation. The results of the comparisons show that these programs would cost 30 percent to 50 percent more than construction of the Three Gorges project. The conclusion is: among all of the comparison programs, the Three Gorges project would cost the less and would provide irreplaceable comprehensive utilization benefits.

The national economic assessment indices for the Three Gorges project are good. According to dynamic calculations, the output from the Three Gorges project would be 13.12 billion yuan higher than the net present value (based on a 10 percent discount on present rates up to the time construction begins). The economic internal income rate is 14.5 percent, which is higher than the 10 percent baseline index stipulated by the State Planning Commission.

After optimized calculations, the cost of building the Three Gorges project compared to the cost of building a substitute program that did not involve construction of the Three Gorges project would be 11.01 billion yuan less at present values, which is equal to 70.2 percent of the Three Gorges project cost at present values of 15.674

billion yuan. The cost at present values of building sooner instead of later is 7.27 billion yuan less (calculating building later at a 12-year delay), which is equivalent to 46.4 percent of the cost at present values of the Three Gorges project. This shows that it would be better to build the Three Gorges project than not to build it and that it would be better to build it sooner than later.

The financial assessment indices of the Three Gorges projects are also good. Calculated according to relevant state stipulations and the electric power production capital profit rate of 10 percent, the cost of electricity supplied to the grid would be 0.093 yuan/kWh, which is a relatively low price. The financial internal income rate would be 11 percent and the capital profit and tax rate would be 12.1 percent, which are higher than the 9 percent for China's electric power industry. The loan repayment period and investment recovery period are both 20.6 years, meaning that the loan could be paid off and the investment recovered the year after construction is completed. This cannot be achieved at other hydropower and thermal power plants. During the period of normal operation, the total annual profits and taxes would be 5.406 billion yuan, which is larger than the total cost of the Gezhouba key water conservancy facility. Sensitivity and risk analysis were also done during the comprehensive economic evaluation. The results of the sensitivity analysis show that all economic and financial assessment indices are stable and that a shift of certain factors in a negative direction would not change the overall conclusion of the assessment. The results of the risk analysis show that the risk of economic benefits being lower than the assessment conclusions is very small and that there is a much greater possibility that they would be greater than the assessment conclusions.

The Three Gorges project would involve a large investment and long construction schedule. There would be only inputs, no outputs, during the first 12 years of construction. Whether or not it would affect achievement of strategic objectives for development of the national economy by the year 2000 requires further study of the macro scope of the national economy. Thus, the comprehensive economics experts group entrusted Institute 710 in the Ministry of Aerospace Industry and the Soft Sciences Institute at Zhejiang University with using numerical simulations to carry out analytical projections. Although the numerical models of the two groups used different data and methods, the overall concept they derived was identical. It was that construction of the Three Gorges project would not affect achievement of the strategic goal of national economic development of quadrupling [the gross value of industrial and agricultural output] by the year 2000, nor would it affect overall levels of per capita national income. Instead, it would be extremely beneficial for development of the national economy after 2000.

VII. The Right Time To Build the Three Gorges Project

To summarize the previous points, the Three Gorges project is a strategic foundation project in China's four modernizations drive that would provide huge comprehensive benefits in flood prevention, power generation, and water- borne shipping. The conclusion of the new feasibility report for the Three Gorges project was that building it would be better than not building it and that there would be advantages to building it earlier rather than later, so it suggested that it the decision be made soon. This was the unanimous view of most comrades among the 400-plus experts.

First, construction of the Three Gorges project is both necessary and urgent. From the perspective of flood prevention, the flood prevention standards on the Jingjiang section of the river are actually too low. Combined with the continued degradation of conditions at Dongting Hu, if we do not build the Three Gorges project, the number of times we will have to use the floodwater diversion area will have to be increased and, in the event of a major flood, there will inevitably be serious and devastating destruction. Moreover, this would disrupt plans for development of our entire national economy. Hydrological phenomena occur according to specific wet and dry cycles. Several decades more than a century have passed since the concentrated occurrence of three huge floods (1788, 1860, and 1870) and the risk of the reoccurrence of a major flood is growing. All the people along both banks of the river have a sense of danger and urgency. If this type of disaster occurs again now, it would cause losses and aftereffects that cannot be compared to the past. The party and government must consider this reality. From the perspective of energy resources and communication, the rich, populous, and prosperous central and east China regions have shortages of energy resources and communication between east and west is inconvenient. Studying future development trends shows that the problems will become increasingly severe. The Three Gorges project has a superior geographic location and concentrated hydraulic resources, and it is the most important east-west shipping channel. Failing to consider its development and utilization, and allowing resources equivalent to 50 million tons of raw coal to flow into the sea unused every year will further exacerbate the pressures on coal extraction and transportation and environmental pollution pressures and will allow shipping on the river to continue to be restricted by natural conditions and be unable to develop rapidly. This would cause irrecoverable losses and cannot be allowed.

As for the sequence of river development, there is a fixed model of "starting with the upper reaches and working later on the lower reaches, starting with tributaries and working later on the trunk", both in China and in foreign countries and in either theory or practice. This is determined by actual natural conditions and economic development requirements. Development on the Columbia and Colorado Rivers in the United States, on the Volga River in the Soviet Union, and on the Huang He in

China all started with the trunk and worked later on the tributaries. As for development of the Chang Jiang, we have built over 100 large reservoirs, over 48,000 medium-sized and small reservoirs, and over 11,500MW of large and medium-sized hydropower stations since the nation was founded, all of them on tributaries with the exception of Gezhouba. According to the Chang Jiang Basin Comprehensive Utilization Plan, work to develop the upper reaches and tributaries will be carried out continuously. Along with the Three Gorges project, none of them can be abandoned and none of them can replace the others.

Second, in regard to the question of China's abilities to build the Three Gorges project, the comprehensive economic experts group has already done extensive analysis in many areas. They feel that China's strengths are entirely capable of building the Three Gorges project at the current state of development of our national economy. As for materials, the Three Gorges project will require a total of 10.82 million tons of cement, 1.95 million tons of steel, and 1.60 million m^3 of lumber. Each year, it will use an average of 550,000 tons of cement, 100,000 tons of steel, and 180,000 m^3 of lumber. China produced 203.37 million tons of cement, 46.98 million tons of steel, and 62.14 million m^3 of lumber during 1988, so the Three Gorges projects will use only an extremely small proportion. As for national income and GNP, calculated at 1986 prices, the total investment for the Three Gorges projects would take up a total of 0.123 percent of our national income and 0.073 percent of our GNP during the construction period (the appraisal used 1986-2008 for the calculations). These two figures are less than half of the indices during the first phase of construction of Baoshan Steel Mill (0.254 percent and 0.216 percent, respectively), so the national economy is capable of bearing the burden.

Of course, the total construction schedule of 20 years for the Three Gorges project is rather long but it would begin generating power in the 12th year, which is not that different from the construction schedule of 8 or 9 years for the first generator to go into operation at regular 1,000MW-grade hydropower stations, and it is not that different compared to construction of a thermal power plant and the associated large mines and haulage railways. If we adopt advanced construction technology and further optimize the design, it is also possible that power could be generated ahead of schedule. The construction schedules for key large projects are always somewhat longer and some capital will have to wait for a while before it can produce benefits. This is unavoidable. As soon as a key project goes into operation, however, it can quickly produce huge benefits. In the state's strategic macro decisions, arranging for a small number of large key projects is entirely necessary. For 6 years after the first generator at the Three Gorges begins generating power, a capacity roughly equal to one Gezhouba can be placed into operation each year, so the reserve strengths are considerable.

Third, as for the technical problems, population resettlement problems, and ecological and environmental problems involved in construction of the Three Gorges project, these have already been reported on above. After 30 years of work and an additional 3 years of comprehensive assessment this time, there is abundant information and the depth of the work done is unusual. All the experts groups pointed out clearly in their conclusions that the Three Gorges project is technically feasible, that no obstructions exist that would be difficult to overcome, and that good arrangements can be made for the resettled population. Not only will they live and work in peace and contentment, but they will also be able to change the present backward economic situation in the reservoir region and the ecological and environmental problem of "becoming poorer as they reclaim more land". In summary, the conditions already exist for construction of the Three Gorges project and I am confident that comrades who have some doubts in these areas will eliminate their concerns after they gain a detailed understanding of the appraisal situation.

Economic construction in China has certainly undergone major rises and falls since the nation was founded. The lesson from these major rises and falls, impatience for success, and waste arising from haste is that they should be deeply remembered and used as lessons. For example, during the Great Leap Forward, the gross value of industrial and agricultural output rose at an annual rate of 18 percent and investments in social fixed assets increased at an annual rate of 40 percent. During the 3-year period from 1985 to 1988, our GNP increased at a yearly rate of 19.4 percent and investments in fixed assets also increased at an annual rate of 19.3 percent (both these figures include inflation factors). Serious aftereffects resulted in both cases. They were mainly the result of a loss of macro control in the entirety and structure of the national economy, particularly in excessively rapid non-productive construction and processing industry. They were not due, however, to problems with one or two strategic key projects. Beginning in 1988, the CPC Central Committee decided on the principle of controlling total amounts, readjusting structures, rectifying sequences, and increasing results, and quickly gained control of the situation. For the Eighth 5-Year Plan, the state took into consideration a yearly GNP growth rate of 5 to 6 percent. After absorbing positive and negative experiences in these two areas, under the correct guidance and leadership of the CPC Central Committee, China's economy will certainly be able to maintain stable and coordinated development and we will certainly be able to avoid past mistakes. Capital to build the Three Gorges project must simply be controlled within social fixed assets investment quotas and will not result in a loss of coordination in the overall national economy. It will only aid in structural readjustments and provide reserve strengths. For such a key project that concerns strategic development of our national economy and the peace and stability of our nation and society, we should set our sights somewhat

longer, look toward the long-term interests and basic interests of our people and nation, and make a correct decision.

Besides macro control, we also have lessons from being impatient for success in some projects in the past. These are: 1) Inadequate preparatory work and incomplete information, such as unclear geological conditions, superficial designs, and pressing to start can cause a whole series of problems, sometimes even a cessation of construction; 2) Inappropriate plans, inadequate appraisal, failure to implement raw materials and motive power, products without sales markets, can make projects unable to produce benefits for a long time after going into operation and sometimes even cause side-effects. It is quite apparent that the Three Gorges project does not fit this type of situation.

In summary, whether we are working from long term plans for the nation or from the urgent situation at present in flood prevention, energy resources, and communication, all show the necessity and urgency of building the Three Gorges project. The Three Gorges project is technically feasible and economically rational, the population resettlement and ecological and environmental problems can be resolved, and our national strengths can bear the burden. The time has now come to give serious consideration to the Three Gorges project. A failure to consider the Three Gorges project will make it impossible to solve the increasingly serious threat of flooding on the middle reaches of the Chang Jiang and it will be impossible to arrange plans for coal, hydropower and thermal power, and water-borne shipping. Spending such a long time on reappraisals ranging from the macro to the micro levels can be called careful and democratic. Making a decision on this foundation is definitely not impatience for success. Instead, it conforms to the CPC Central Committee's active and careful principles adopted for the Three Gorges project. As for the time to actually begin construction, the state can decide according to the various conditions. The appraisal report suggests that preparatory work begin during the later part of the Eighth 5-Year Plan.

Hydropower Development on the Upper Huang He and the Northwest Power Grid

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[Article by Qian Jiaxiang [6929 1367 7534] of the Northwest China Electric Power Industry Management Bureau: "Cascade Hydropower Station Development on the Upper and Middle and Reaches of the Huang He Has Promoted the Formation and Development of the Northwest China Power Grid"]

[Text] The Northwest China Power Grid is one of China's six large grids. The installed hydropower generating capacity on the upper and middle reaches of the Huang He accounts for over 40 percent of the installed generating capacity in the Northwest China Grid, so it is an important part of the Northwest Grid. The Northwest Grid and the various cascade hydropower stations on the upper and middle reaches of the Huang He are interdependent, jointly developed, and have extremely close interrelationships. They have had a major impact on the national economy and social development in the northwest China region and substantial effects on economic development in the entire Huang He basin.

I. Construction of Cascade Hydropower Stations on the Upper and Middle Reaches of the Huang He and the Formation and Development of the Northwest China Power Grid

Five cascade hydropower stations were completed at Longyang Gorge, Liujia Gorge, Yanguo Gorge, Bapan Gorge, and Qingtong Gorge on the upper and middle reaches of the Huang He from the early 1960's to the late 1980's. This group of five cascade hydropower stations is the largest group in China at present in both installed generating capacity and reservoir capacity. This group of cascade hydropower stations has produced enormous comprehensive benefits and had a major impact on the formation and development of the Northwest China Power Grid. This is particularly true for the big Longyang Gorge and Liujia Gorge hydropower stations, which have had a decisive impact. I will now describe the situation in each phase of development of the Northwest Grid:

A. The phase of independent development of each provincial (autonomous region) grid in northwest China

From shortly after Liberation until the early 1970's, a period of about 20 years, the electric power industries of Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang developed independently. They maintained their own equilibrium and were not interconnected. They formed several non-interconnected 110 kV power grids like the Guanzhong Grid in Shaanxi, the Lanzhou Grid, Yongchang Grid, and Tianshui Grid in Gansu, Xining Grid in Qinghai, Shiyinqing Grid in Ningxia, Urumqi Grid in Xinjiang, and so on. No multi-province large regional grids were formed during this phase.

B. The phase of the gradual formation of the 330 kV main network for the Northwest China Power Grid

Liujia Gorge hydropower station began generating power in 1969 and created the prerequisite for starting to form the Northwest China Grid. To take full advantage of the role of Liujia Gorge's hydropower resources, the 220 kV Jian- Hong line was built in 1971 (from Jiansheping transformer station in Gansu to Hongwan transformer station in Qinghai) to interconnect the Lanzhou Grid with the Xining Grid and a multi-province interconnected grid began to appear in the northwest China region. The 330 kV Liu-Tian-Guan line (from Liujia Gorge hydropower station through Qin'an transformer station in Gansu's Tianshui region to Tangyu transformer station at Guanzhong in Shaanxi) was placed into service in 1972. This was China's first ultra-high voltage circuit. It extended for 534 km and interconnected the

Shanxi Power Grid and Gansu Power Grid to form the Shaan-Gan-Qing [Shaanxi-Gansu-Qinghai] Power Grid, indicating the start of the formation of a 330 kV main network in the Northwest China Power Grid.

During the nearly 15-year period from the early 1970's to the mid-1980's, as northwest China's electric power industry grew, the Northwest Grid was also gradually reinforced. Besides the Liujia Gorge, Yanguo Gorge, Bapan Gorge, and Qingtong Gorge cascade hydropower stations on the upper and middle reaches of the Huang He, there were also corresponding developments of thermal power construction in northwest China. The Hancheng power plant (380MW) and Qinling power plant (1,050MW) in Shaanxi, Dawukou power plant (400MW) in Ningxia, and others were completed in succession and the 330 kV main network was extended to Qinling and Hancheng power plants, while Dawukou power plant used a 220 kV line to transmit its power out. Since 1985, the Shaanxi-Gansu-Qinghai Grid has been interconnected with the Ningxia Grid via the Jing-Qing line (running from Jingyuan transformer station in Gansu to Qingtong Gorge transformer station in Ningxia. This line was designed for 330 kV but operated at a reduced voltage of 220 kV during the initial stages to form the Shaanxi-Gansu- Qinghai-Ningxia Power Grid which covers all the economically developed regions of northwest China. By the end of 1985, the Northwest Grid's installed generating capacity had reached 5,490MW, including 3,020MW of hydropower and 2,470MW of thermal power, and it had 1,278 km of 330 kV lines, more than double the amount when the Liu-Tian-Guan line began operation, and 2,125 km of 220 kV lines. The 15-year period beginning in 1972 was the initial stage of the 330 kV main network. The power source structure within the grid was hydropower in the west and thermal power in the east. The grid's load was concentrated in the Lanzhou region and Guanzhong region. There were major current variations in the grid, with hydropower and thermal power complementing each other in the grid, with rather good economic results. Because the main network in the grid operated as a single loop, however, transmission power levels were rather high and there were rather acute safety and stability problems as a result. As a result, much work was done focused on raising safety and stability levels in the grid.

C. The stage of development of the 330 kV main network in the Northwest China Grid

In October 1986, the tap reservoir at Longyang Gorge on the upper reaches of the Huang He began lowering its gates to impound water. The No 1 generator at Longyang Gorge power station began generating electricity in September 1987, and all four of its generators were in operation by June 1989. To transmit the electricity from Longyang Gorge hydropower station to east China, several 330 kV Longyang Gorge transmission projects were built in succession, including Huayuan transformer station and Huangjiazhai transformer station in Qinghai, Haishiwan transformer station, Liujia Gorge switching station, Longxi transformer station, and Yincheng transformer station in Gansu, Maying transformer station in Shaanxi, and other key 330 kV power transformation stations, as well as the Long-Hua [Longxi-Huayuan] single and double-loop lines, Hua-Hai [Huayuan-Haishiwan] single and double-loop lines, Long-Huang [Longxi-Huangjiazhai] line, Hua-Huang [Huayuan-Huangjiazhai] line, Long-Hai [Longxi-Haishiwan] line, Long-Ma [Longxi-Maying] line, Ma-Zhuang [Maying-Zhuanglang] line, Hai-Bai [Haishiwan-Baiyin] line, and other 330 kV lines. Construction of the Longyang Gorge hydropower station and Longyang Gorge transmission projects indicated a new stage in the development of the Northwest China Grid. By the end of 1989, the total installed generating capacity in the Northwest Grid had grown to 7,500MW, including 3,660MW in hydropower and 3,840MW in thermal power, and it had 2,680 km of 330 kV lines and 2,621 km of 220 kV lines. This basically formed a dual-loop 330 kV main network framework extending for about 1,200 km from west to east. Power transmission capacity was increased, the grid structure was strengthened, and there were additional improvements in safety and stability conditions. There were new developments in the grid's relay protection devices, safety automation devices, grid communications, and dispatching automation. This included a 33-station 480-circuit digital microwave circuit from Xi'an to Longyang Gorge, the first long-distance unattended microwave circuit in China, which was placed into operation in 1989.

The formation and development process of the Northwest China Grid as described above shows clearly that all of the cascade hydropower stations on the upper and middle reaches of the Huang He, especially construction of Longyang Gorge and Liujia Gorge hydropower stations, have played a promoting role in development of the grid.

II. Construction of Cascade Hydropower Stations on the Upper and Middle Reaches of the Huang He Has Brought Enormous Benefits to Northwest China and the Northwest China Power Grid

The various cascade hydropower stations on the upper and middle reaches of the Huang He have produced enormous social and economic benefits. These comprehensive benefits include both the benefits of electric power and benefits other than electric power. I will only outline the electric power benefits below:

A. Power generation benefits

Among China's large power grids, the Northwest China Power Grid has the largest proportion of hydropower (49.33 percent).

The Northwest Grid covers three main water systems: the upper and middle reaches of the Huang He, the Han Jiang, and the Bailong Jiang. Most of its hydropower installed generating capacity is concentrated on the upper and middle reaches of the Huang He. According to statistics for the period 1980 to 1989, the cascade

hydropower stations on the upper and middle reaches of the Huang He accounted for 34.1 to 43.5 percent of the Northwest China Grid's installed hydropower generating capacity and 23.3 to 43.7 percent of its yearly power output. This shows that the cascade hydropower stations on the upper and middle reaches of the Huang He are extremely important for the Northwest China Grid, both in terms of electric power and power output. Especially important is the combined operation of the two big Longyang Gorge and Liujia Gorge reservoirs. As a result, when the Northwest Grid is arranging reservoir operation patterns, it must make unified arrangements with the grid's operating patterns and unified consideration must be given to reservoir dispatching and grid dispatching. This is a basic characteristic of the Northwest China Grid.

B. Pumped-storage and regulation benefits

Longyang Gorge reservoir has a normal water level of 2,600 m and a dead water level of 2,530. It has a regulable reservoir capacity of 19.357 billion m^3. During the initial period of operation, the normal water level was 2,575 m and it had a regulable reservoir capacity of 10.686 billion m^3. Liujia Gorge reservoir has a normal water level of 1,735 m, a dead water level of 1,694 m, and a regulable reservoir capacity of 3.811 billion m^3. Longyang Gorge and Liujia Gorge reservoirs are huge impoundment reservoirs and huge storers of energy. It has been estimated that these two reservoirs could store 10.3 billion kWh, which is equal to storing 6 million tons of raw coal. They hold first place in China in the amount of energy stored. This is a major advantage of the Northwest China Grid. Because these two reservoirs play a huge energy-storing role, they create a very powerful compensation role. This compensation role is extremely important both for normal operation of the Northwest Grid and for comprehensive water use on the upper and middle reaches of the Huang He. Below, I will describe perennial regulation, annual regulation, daily regulation, and real-time regulation.

1. Perennial regulation role. The Northwest China Survey and Design Academy did several program comparisons and studies of combined operation of the Longyang Gorge and Liujia Gorge reservoirs. Longyang Gorge reservoir is a perennial regulation reservoir while Liujia Gorge reservoir is a less than year-round regulation reservoir. In terms of geographic position, the former lies above while the latter lies below, and comprehensive water use requirements are mainly completed by relying on Liujia Gorge reservoir. During most months of a year, there are different requirements for flood prevention, icing prevention, irrigation (winter irrigation, spring irrigation, and summer irrigation) and reservoir silt discharging. In terms of head benefits, Liujia Gorge reservoir has better head benefits because of its smaller reservoir capacity. From the perspective of power use loads, there are different needs for each month of a year. Thus, based on different power use and water use requirements at different times, unified arrangements are made for grid and reservoir operation and maintenance. For Longyang Gorge reservoir, a large reservoir with a perennial regulation role, it is even more important that calculations be made in conjunction with a long series of hydrological data covering 61 years to enable it to attain its proper power generation and irrigation guarantee rates.

Analysis of historical data covering 245 years and hydrological data covering 61 years indicates that a total of four long dry spells lasting about 11 years have occurred on the upper reaches of the Huang He. During the dry spell from 1922 to 1932, the perennial average flow rate was only 475 m^3/s, equal to 73 percent of the perennial average flow rate. Implementing a perennial dispatching program for the Longyang Gorge and Liujia Gorge reservoirs under conditions of computing guarantee rates, the Northwest China Grid can extract 15 billion kWh of electric power a year from the cascade hydropower stations on the upper and middle reaches of the Huang He. This amount of power is equivalent to 38 percent of the total amount of power generated in the entire Northwest Grid during 1989, which is a substantial advantage for stable power supplies in the grid and a major advantage for cascade comprehensive water use.

2. Annual regulation role. Before Longyang Gorge power station began generating power, Liujia Gorge hydropower station had already played a perennial regulation role rather well. Large amounts of power were generated from hydropower during rainy periods each year and thermal power was used for peak regulation or maintenance and reserve arrangements. Hydropower was used for peak regulation or maintenance and reserve arrangements during dry periods. The results were very good using hydropower and thermal power for mutual compensation. After Longyang Gorge hydropower station began generating power, this annual regulation role was fostered even better.

3. Daily regulation role. A daily regulation role means playing a role in peak regulation in the grid. The peak-to-valley differential on the daily load curve in the Northwest China Grid is about 25 to 30 percent of the maximum load. Peak regulation via hydropower on the upper and middle reaches of the Huang He has played a major role in raising safety and economical operation levels in the grid and improving power quality. For example, Liujia Gorge hydropower station is the main peak regulation station in the Northwest Grid. This power station can carry full power during peak loads and reduce its generator output to zero during valley loads. This operational arrangement played a major role in fully fostering the capabilities of thermal power and reducing the power shortage during a serious power shortage in the grid from 1986 to 1989. Because of hydropower's rather powerful peak regulation capabilities, thermal power generators in the grid can operate at full loads for 24 hours. Statistical data for 1987 and 1988 indicate that the average utilization time for thermal power generators in the Northwest China Grid was 400 to 500 hours higher than the national level.

The frequent peak regulation processes in the hydropower generators on the upper and middle reaches of the Huang He caused fracturing of the braking rings, accelerated aging of the electrical insulation, severe wear on the turbines and guide blades during no-load operation, and other problems. This was particularly true for Liujia Gorge hydropower station, which bore the heaviest burden of peak regulation tasks and encountered the most problems. Measures are now being adopted gradually to solve them. After Longyang Gorge hydropower station went into operation, it has been bearing the system's primary peak regulation tasks together with Liujia Gorge hydropower station and the situation will gradually improve.

4. Real-time regulation role. This is a frequency regulation role. Output at Liujia Gorge hydropower station is 1,160MW and it has been the main frequency regulation power station in the Northwest China Power Grid for quite some time. After Longyang Gorge hydropower station began operating, overall regulation is based on the entire grid's operating patterns, which means that a decision must be made on whether Longyang Gorge hydropower station or Liujia Gorge hydropower station will serve as the main frequency regulation power stations. As the grid dispatching automation plan is implemented, overall regulation in northwest China will have AGC functions and under normal conditions, the grid's frequency regulation tasks will be divided among all of the hydropower stations in the grid and will conform to grid and reservoir economical operation requirements, so it will be easier to achieve AGC than in other grids dominated by thermal power. This is another advantage of the Northwest Grid.

C. Supporting safe and stable grid operation

The two big hydropower stations at Longyang Gorge and Liujia Gorge are directly connected to the 330 kV main network in the Northwest China Power Grid and have become the primary power source support point for northwest China, so they play an extremely significant role in grid stability levels. During the initial period of grid formation, the main network transmitted power from west to east at a static stability level of 350MW and a dynamic stability level of 320MW. As the grid grew and various stability measures were adopted, the static stability level rose to 460MW and the dynamic stability level rose to 450MW. After Longyang Gorge hydropower station began generating electricity, the static stability level for transmitting power to the east in the main network was again increased to 800MW and the dynamic stability level to 550MW, which is still rather low. After Liujia Gorge switching station goes into operation, Liujia Gorge hydropower station will become a powerful supporting point in the grid and the dynamic stability level will be increased to 710MW. As several new stabilization measures are adopted in the future, it will still be possible to increase safety and stability levels in the grid further.

D. Longyang Gorge and Liujia Gorge hydropower stations, which are connected directly to the 330 kV main network, play a decisive role in controlling voltage levels in the grid. The Northwest China Power Grid now has 2,680 km of 330 kV lines, 2,621 km of 220 kV lines, and a high-voltage line charging power of about 1,500 MVAR. Because there is insufficient passive compensation equipment capacity in the grid and the distribution is also irrational, main network voltages were slightly high during the initial period of operation at Longyang Gorge hydropower station and during late-night valley load periods, which made voltage specification attainment rates in the four provinces (autonomous regions) lower than the national average. To improve the voltage situation in the main network, besides building several additional high- voltage reactors in the grid, adopting phase advancing operation for the large water turbine generators is an extremely effective measure. The results of experiments indicate that when the output power of each of the hydropower generators at Longyang Gorge power station is 320MW, their passive phase advancing capacity is 120MW. When the output power of the five generators at Liujia Gorge power station is 260MW, their passive phase advancing capacity is 80MW. The rather powerful phase advancing capacity of large water turbine generators gives them rather good results and economy in improving main network voltages.

The above is only a description of the benefits from the cascade hydropower stations on the upper and middle reaches of the Huang He in the four areas of power output, regulation, stability, and voltage regulation. Hydropower itself is a renewable, clean, and rather inexpensive energy resource. Because the economic benefits from utilizing hydropower are multifaceted, they will not be discussed in detail in this article.

III. Construction of Cascade Hydropower Stations on the Upper and Middle Reaches of the Huang He Will Promote Further Development of the Northwest China Grid

1. According to the "Huang He Comprehensive Utilization Program Technical Economics Report", the primary task of developing the section of the upper reaches of the Huang He from Longyang Gorge to Qingtong Gorge (abbreviated as the Long-Qing section) is power generation. This section of the river has been called China's hydropower "motherlode" and it has huge hydropower resource advantages. The total head of the Long-Qing section is 1,465 m. According to the Northwest China Survey and Design Academy plan, a total of 15 cascades could be developed for an installed generating capacity of about 12,460MW and yearly power output of about 50 billion kWh. The academy also made a supplementary proposal for 10 medium-sized and small cascade hydropower stations that could have an installed generating capacity of 1,600MW and yearly power output of 6.9 billion kWh. This section of the river has advantages like a small amount of engineering, small inundation losses, short construction schedules, small investments, relatively complete preparatory work,

rather mature experience in hydropower construction on the upper reaches of the Huang He, and so on. It is an extremely valuable energy resource in the northwest China region. Development of the Long-Qing section could be used not only for power generation and peak regulation but would also provide benefits in many areas. It could not only resolve peak regulation problems in the Northwest Grid but could also provide supplementary peak regulation for a large region outside the grid. Thus, development of the Long-Qing section is extremely necessary for Gansu and Qinghai provinces, which have coal shortages, and for Shaanxi and Ningxia provinces, which have inadequate peak regulation capacities. The state has already included hydropower on the upper and middle reaches of the Huang He among the 12 hydropower base areas to be built first. At present, because we are in a process of system reform, hydropower investment channels have not yet been straightened out and development of hydropower on the upper and middle reaches of the Huang He may encounter several temporary difficulties. I am confident that these problems will gradually be resolved as the system reform proceeds.

2. Hydropower construction on the upper and middle reaches of the Huang He will inevitably bring further development of the Northwest China Power Grid. Starting from construction of the first line in the Northwest Grid's 330 kV main network in 1972, after nearly 20 years of growth, it has now attained a scale of 3,000 km of lines and it is expected that the grid's total 330 kV lines will reach 10,000 km by the year 2000. There will be over six 330 kV line loops from Qinghai to transmit power to east China and grids at the 330 kV voltage grade will tend toward saturation. As hydropower development on the upper and middle reaches of the Huang He proceeds further, especially with construction of Laxiwa hydropower station (6,000MW), it is expected that the Northwest China Power Grid will develop to the next higher voltage grade shortly after the year 2000 and the Northwest Grid will develop to a new stage. Technical assessment of the next higher voltage grade is now in progress in the relevant departments.

3. The scale and progress of hydropower construction on the upper and middle reaches of the Huang He will be a major factor in the selection of the next higher voltage grade in the Northwest China Grid. Selection of the next higher voltage grade will involve an important technical economics decision and will be an ultra-long term decision. It took 30 years or slightly longer for the 330 kV voltage grade in the Northwest China Grid from the time it began forming until it developed to the point where it is basically saturated. The time period for using the next higher voltage grade should be no less than 30 years. Thus, we must do ultra-long term analysis and research concerning load development forecasts, energy resource structure deployments, the relationship between energy resource construction and the large area outside the region, and so on for the Northwest Grid. Only on this foundation will we be able to make a rational selection of the next higher voltage grade for the Northwest China Grid. This would encompass cascade hydropower on the upper and middle reaches of the Huang He including hydropower construction on the Long-Qing section and construction on the section of the river above Longyang Gorge, and expansion of already completed cascades to satisfy system peak regulation and hydropower utilization requirements. We should also give additional attention to the appearance of the feasibility of achieving a program for transmitting water from south to north China on the upper Huang He, and make forecasts of the scale and progress of cascade hydropower development on the upper and middle reaches of the Huang He to ensure that the next higher voltage grade aids in development of the hydropower potential and advantages on the upper and middle reaches of the Huang He.

Report on Hydropower Potential of Mainstream of Jinsha Jiang

916B0080 Beijing SHUILI FADIAN [WATER POWER] in Chinese No 6, 12 Jun 91 pp 1-4

[Article by the Research Project Group on Strategies for Construction of the Southwest China Hydropower Base Area: "Report on an Investigation of Hydropower Resources on the Trunk of the Jinsha Jiang"]

[Text] The Research Project Group on Strategies for Construction of the Southwest China Hydropower Base Area organized by the China Electric Power Enterprise Integration Commission and China Hydroelectric Power Engineering Society organized some energy resource and hydropower experts to conduct an investigation of the dam sites and part of the area to be inundated for Hutiao Gorge, Guanyinyan, Xiluodu, Xiangjiaba, and other primary power stations on the middle and lower reaches (between Shigu, Yunnan and Yibin, Sichuan) of the Jinsha Jiang between 16 Nov and 4 Dec 90. This investigation received active support and assistance from the leadership and electric power bureaus of Sichuan and Yunnan Provinces, and the prefectures, autonomous prefectures, cities, and counties along the way which enabled success in the investigation. Comrades in the investigation group were unanimous in their view that the Jinsha Jiang has extremely abundant hydropower resources and superior development conditions, and is one of China's biggest hydropower base areas and the nucleus of the Southwest China Hydropower Resource Base. Including it in the national balance of primary energy resources and accelerating its development would be of major strategic significance in promoting economic development in the southwest China region, improving China's industrial structure and the ecology and environment in the upper reaches of the Chang Jiang, and achieving the transmission of

power from west to east China. The report on the main conditions and proposals follows:

I. The Jinsha Jiang Has Extremely Abundant Hydropower Resources and Superior Development Conditions

The upper reaches of the Chang Jiang from Yushu in Qinghai to Yibin in Sichuan is called the Jinsha Jiang, which flows through Qinghai, Tibet, Sichuan, and Yunnan. Its total length is 2,290 km and the basin covers an area of 490,000 km^2. The amount of water is abundant and stable and it has a large and concentrated head. The perennial average flow rate at the mouth of the river (Yibin) is 4,920 m^3/s and the yearly runoff is 155 billion m^3, about 3 times the Huang He. The trunk has a head of 3,280 m and developable hydropower reserves of 75,120MW. Moreover, there is little variation in the amount of water, with the ratio between the wettest and driest years being just 1.38. The superiority of its hydropower conditions are seldom seen in the world. Based on the preliminary plan by the Chang Jiang Water Conservancy Commission, the upper reaches segment of the Chang Jiang (from Yushu to Shigu) is divided into 9 cascades for development with an installed generating capacity of 16,540MW and yearly power output of 80 billion kWh. The middle reaches segment (from Shigu to Panzhihua) is divided into 5 cascades for development with an installed generating capacity of 17,000MW and yearly power output of 96.2 billion kWh. The lower reaches segment (from Panzhihua to Yibin) is divided into 4 cascades for development, with an installed generating capacity of 41,580MW and yearly power output of 189 billion kWh. The total is a developable installed generating capacity of 75,120MW and yearly power output of 365.2 billion kWh (Table 1), equal to 20 percent of China's total developable installed generating capacity and 19 percent of our developable power output. The yearly power output would be equivalent to 100 million tons of standard coal, which would occupy a significant status in China's balance of primary energy resources.

Table 1. Kinetic Energy Indices for Cascade Hydropower Stations on the Trunk of the Jinsha Jiang

Name of power station		Construction site	Total reservoir capacity (billion m^3)	Regulation reservoir capacity (billion m^3)	Installed generating capacity (MW)	Guaranteed output (MW)	Yearly power output (billion kWh)	Utilization time (hours)
	Dongjiuwei	Danko, Sichuan and Yushu, Qinghai	0.195	0.120	160.5	40.1	0.903	5,626
	Shaiwei	Danko, Sichuan and Yushu, Qinghai	0.170	0.100	176.8	43.7	0.997	5,639
	E'nan	Danko, Sichuan and Jomda, Tibet	3.110	1.20	900	196	4.36	4,844
Upper	Baili	Baiyü, Sichuan and Jomda, Tibet	8.50	2.70	1,500	460	7.43	4,953
Reaches	Jiang Qu mouth	Baiyü, Sichuan and Gonjo, Tibet	7.60	1.20	3,200	1,132	16.05	5,016
	Batang	Batang, Sichuan and Gonjo, Tibet	3.70	0.85	2,500	848	11.33	4,532
	Wudalong	Batang, Sichuan and Markam, Tibet	14.10	4.10	2,800	987	12.92	4,614
	Baimian	Derong, Sichuan and Deqen, Yunnan	3.80	1.20	2,800	990	12.94	4.621
	Tuoding	Deqen, Yunnan	5.90	2.10	2,500	670	13.1	5,240
	Subtotal		47.075	13.57	16,537.3	5,366.8	80.03	4,839
	Hutiao Gorge	Lijiang, Yunnan	18.16	10.61	6,000	2,870	30.29	5,048
	Hongmenkou	Yongsheng, Yunnan	8.58	1.85	4,000	2,381.2	25.042	6.621

Table 1. Kinetic Energy Indices for Cascade Hydropower Stations on the Trunk of the Jinsha Jiang (Continued)

Name of power station		Construction site	Total reservoir capacity (billion m^3)	Regulation reservoir capacity (billion m^3)	Installed generating capacity (MW)	Guaranteed output (MW)	Yearly power output (billion kWh)	Utilization time (hours)
Middle	Zili	Lijiang, Yunnan and Yongsheng, Yunnan	1.22	0.21	2,000	1,283.5	13.338	6,669
Reaches	Ludila	Binjiang, Yunnan	5.92	2.22	2,500	1,299.4	14.020	5,608
	Guanyinyan	Panzhihua, Sichuan	3.37	0.77	2,500	1,168.0	13.540	5,416
	Subtotal		37.25	15.66	17,000	9,002.1	96.23	5,661
	Wudongde	Huidong, Sichuan and Luquan, Yunnan	4.00	1.60	7,400	2,879	33.91	4,582
Lower	Baihetan	Ningnan, Sichuan and Qiaojia, Yunnan	19.50	9.30	12,500	4,926	56.87	4,550
Reaches	Xiluodu	Leibo, Sichuan and Yongshan, Yunnan	12.06	6.62	10,080/ 14,480	3,460/5,868	53.16/65.84	5,27 4/4,425
	Xiangjiaba	Yibin, Sichuan and Shuifu, Yunnan	4.77	0.91	5,000/7,200	1,367/2,889	26.18/32.41	5,236/4 ,501
	Subtotal		40.33	18.43	34,980/ 41,580	12,632/ 16,562	17 0.12/ 189.03	4,863/4,546
TOTAL			124.655	47.66	68,517.3/ 75,117.3	27,000.9/ 30,931	346.38/ 395.29	5,055/4,863

The Jinsha Jiang runs through high mountain gorges and has the terrain and geological conditions for building high dams. Almost every one of the cascades in the middle and lower reaches has a developable capacity of more than 2,500MW, especially Baihetan and Xiluodu power stations in the lower reaches, which would both have installed generating capacities of more than 10,000MW. The first cascade in the middle reaches, Hutiao Gorge power station, could have a reservoir capacity of about 30 billion m^3 and it would be a tap reservoir with excellent regulation properties. Sustained cascade development could form a powerful hydropower station cluster base area.

The technical economics indices of the various cascade power stations on the Jinsha Jiang, including project construction costs, inundation losses, population to be resettled, and so on, are superior to large hydropower stations in other regions of China. The Chengdu and South Central China Survey and Design Academies are now doing feasibility research on Xiluodu and Xiangjiaba power stations. The preliminary technical economics indices they have provided show that there are extremely few comparable hydropower station projects. Their unit construction cost per kW is lower than thermal power projects in both cases and their inundation and population resettlement per unit kW are only about one-tenth that of regular projects. The other hydropower stations being considered are basically similar as well.

For a long time, because the geographical location of the Jinsha Jiang is somewhat to the west, survey and design work have been insufficiently extensive and people's direct perceptions of the Jinsha Jiang have been that it has a sparse population and inconvenient communication, is located in a region of frequent earthquakes, and has rather thick riverbed capping strata, so its development conditions are poor and the difficulty great.

After this investigation and hearing the views of the relevant design academies, comrades in the investigation group have a common new understanding of development of the Jinsha Jiang.

1. There have already been rather substantial improvements in communication conditions and the construction environment. Since reform and opening up, development of the local economy has spurred urban construction in the river basin and led to substantial improvements in communication conditions. Formal highways are already open to the dam sites for the power stations in the plan that were investigated this time like Hutiao Gorge, Guanyinyan, Xiluodu, Xiangjiaba, and so

on, and there are towns near the dam sites that could provide support, offering favorable conditions for survey, design, and construction of the power stations.

2. A better understanding has been gained of the geological and earthquake conditions and dam construction conditions. Many years of work by the relevant survey and design units, especially feasibility research on Xiangjiaba and Xiluodu power stations, further clarified the geological and earthquake conditions. Looking at regional structures, the region is in an area of frequent earthquakes, but fracture zones can be avoided and dam sites chosen in relatively stable zones with excellent geological conditions. The area upstream and downstream from the dam area at Xiluodu is limestone, but seven of the dam lines chosen are in relatively integral basalt stable regions. Analysis of data from the drilling of 98 bore holes for a total depth of 15,336 m and 37 exploratory tunnels extending for a total length of 4,868 m confirms that there are extremely superior geological conditions for dam construction. The riverbed capping strata at the dam area at Xiangjiaba are relatively thick, but survey research indicates that the deepest capping strata at the chosen dam line are just 20-odd m thick, so they are no longer a factor that would restrict dam construction.

In summary, improvement in external construction conditions as a result of economic development in the region and intensification of preparatory work indicate that development of the Jinsha Jiang is no longer as difficult and remote as was originally thought. Moreover, it is rich in hydropower resources and has extremely superior economic indices and development conditions, so the pace of development should be accelerated.

II. Developing Hydropower Resources on the Jinsha Jiang Is of Major Political and Economic Significance for Spurring Economic Development in the Southwest China Region, Improving the Structural Deployment of China's Industry, Improving the Ecology and Environment on the Upper Chang Jiang, and Promoting National Unity

Sichuan and Yunnan Provinces have extremely abundant hydropower resources and they are now actively developing hydropower resources in the Dadu He, Yalong Jiang, Lancang Jiang, and other river basins to meet their electric power needs, and they are quite enthusiastic about developing the Jinsha Jiang. Since reform and opening up, there have been substantial developments in economic construction in Sichuan and Yunnan, but they have mainly been concentrated in the central regions. With the exception of Yibin, Panzhihua, and other cities, most regions in the Jinsha Jiang basin are economically underdeveloped and in a relatively impoverished state. They do have abundant hydropower resources, mineral resources, and biological resources, however, and development to take full advantage of their local resources is essential for spurring economic growth in the region. This first of all requires development of the hydropower resources of the Jinsha Jiang. During this investigation, comrades in Sichuan and Yunnan and local governments along the river all wanted to accelerate development of the Jinsha Jiang to convert its resource advantages into economic advantages as quickly as possible. Using development of the Jinsha Jiang to promote local mineral resource exploitation and economic development could improve the structural deployment of China's industry. In conjunction with territorial renovation, this could greatly improve the ecology and environment of the upper Chang Jiang. It is also of major political and economic significance for eliminating poverty in minority nationality regions as quickly as possible, promoting national unity, and consolidating the southwest frontier.

III. Development of the Jinsha Jiang Would Have Major Strategic Importance for Achieving the Transmission of Electric Power from West to East China and Improving the Primary Energy Resource Structure

Hunan, Hubei, and Jiangxi provinces in central China and the southeast coastal region have energy resource shortages and shipping coal from north to south China has already created heavy pressure on transportation. Shortages of energy resources and electric power are factors which restrict economic development in these regions. As the national economy grows, there will be ever-increasing demand for energy resources and electric power and there will be greater coal and transportation shortages. China's coal output must double to about 2 billion tons within 20 to 30 years to satisfy this region's energy resource needs, so while we may be able to supply the energy resources, transportation will be unable to bear the burden.

China has already begun developing nuclear power, and it is entirely necessary for the state to arrange for construction of nuclear power plants along the southern coast. However, the construction costs of nuclear power are expensive at present and we cannot develop it in large amounts, so relying on construction of nuclear power to solve the energy resource problems of these regions will be unrealistic for quite some time to come. However, the southwest China region has rich hydropower resources, especially on the Jinsha Jiang, that could be used to transmit a substantial amount of electric power to central and east China. Preliminary estimates indicate that before the year 2020, if we build several 5,000 to 10,000MW-grade large hydropower stations at Xiluodu, Xiangjiaba, Baihetan, and so on, it would be possible to transmit about 20,000MW of power to central and east China. By about 2050, if we basically complete sequential cascade development on the trunk of the Jinsha Jiang, we could transmit about 50,000MW of power to central and east China. This would make an enormous contribution to the energy resource and electric power balance in central and east China.

As for the question of power transmission, preliminary research indicates that it could be transmitted to the outside via three routes: north, central, and south. The northern route would pass through the Three Gorges and

Gezhouba to Wuhan and would be used to relay power sources to east China. The central route would pass through Guizhou and western Hunan and would transmit east to Changsha and Nanchang. The southern route would pass through Guangxi and transmit power to Guangzhou.

In summary, building the Jinsha Jiang into China's powerful hydropower base area as quickly as possible and taking full advantage of its abundant, cheap, and non-polluting energy resources is of major strategic significance for achieving the transmission of power from west to east China, participating in the primary energy resource balance, and improving the energy resource structure.

IV. Reinforce Leadership, Unify Understandings, Focus on Preparatory Work, Prepare Good Basin Plans

Building a huge hydropower station base area on the Jinsha Jiang would take 30, 40, or even more years. If we immediately make major efforts to reinforce preparatory work now, assess feasibility research on the first group of projects and then prepare preliminary designs and include them among projects for construction, it would take until about 2005 or 2010 to complete them and begin generating and transmitting power. Whether we are looking from the perspective of a medium and long-term balance of energy resources in China or from the substantial schedules required to develop hydropower, now is the time for development of the Jinsha Jiang to be included in today's order of the day. The main thing now is to reinforce leadership, unify understandings, and focus on programs and key project survey and design. In this area, the Central Water Conservancy and Hydropower Planning and Design Academy, the relevant design academies, and the Chang Jiang Water Conservancy Commission have already done a great deal of work, but there is still a much work that must be done more extensively and many key S&T questions that require focused organization of research to attack key problems.

First, there is still no complete cascade development plan for the entire Jinsha Jiang. Although plans have been prepared for the lower reaches, the work at present is still concentrated on the Xiluodu and Xiangjiaba sites. No planning has been done for the middle reaches segment and work on the upper reaches segment is still at the survey stage. To establish a comprehensive and scientific foundation for comprehensive development of the Jinsha Jiang, there must be unified coordination and greater intensification of planning work.

Second, there are several major S&T questions, such as selection of dam sites in an earthquake region, key technologies involved in high dam and large-span underground plant building construction, deeply-buried large tunnel design and excavation technology, high-head and large capacity generator design and manufacture, selection of extra-high voltage DC power transmission and transformation voltages and equipment design and manufacture, selection of routes for lines to transmit power from west to east China, and so on that require organization of the relevant departments, major efforts at cooperation, extensive work, active attacks on key problems, and making achievements.

To summarize all the above, development and construction of the Jinsha Jiang hydropower base area would occupy an important status in China's future primary energy resource balance, and the development conditions are extremely superior. Without development of the Jinsha Jiang, talk of transmitting power from west to east China is meaningless. Given the depth of preparatory work at the present time, however, a considerable amount of time will still be needed. If we fail to seize the opportunity now, the conditions for development may not be ready when needed, and we will lose it. For this reason, we propose:

1. A large part of the Jinsha Jiang is a boundary river between Sichuan and Yunnan Provinces. Its development and utilization would touch on a wide area, and the manpower, materials, and finances of Sichuan and Yunnan Provinces cannot bear the burden. The state should make unified arrangements and motivate the initiative in the energy-short regions of south China. We propose that the Ministry of Energy Resources (or an even higher level) lead the way in organizing all relevant departments in the central government and Sichuan and Yunnan Provinces to establish the Jinsha Jiang Development Leadership Group to coordinate relationships among the various aspects and made unified policy decisions. Now, we should charge the Central Water Conservancy and Hydropower Planning and Design Academy with organizing the relevant survey and design units to prepare a development plan as soon as possible for this river segment according to the development principle of focusing on power generation in conjunction with consideration of the comprehensive utilization benefits for all aspects, and to suggest a preparatory work plan for the first group of development projects. They should organize the relevant units to carry out attacks on key S&T problems in development and provide a comprehensive, scientific, and reliable foundation for decisions concerning development of the entire Jinsha Jiang hydropower base area.

2. Deal with the question of funds for preparatory work. We propose the establishment of a preparatory work fund for development of the Jinsha Jiang. The source of capital should be like those for development of coal, petroleum, and other energy resources. The state should arrange for Jinsha Jiang hydropower resource survey funds of 50 million yuan a year. This money could come from the hydropower preparatory work fund of 0.002 yuan/kWh that is requisitioned from the amount of power generated by hydropower.

Note: The Jinsha Jiang Trunk Hydropower Resource Investigation Group was composed of China Electric Power Enterprise Integration Commission deputy

director You Jishou [3266 0679 1108], China Hydroelectric Power Engineering Society deputy director Liang Yihua [2733 4135 5478], China Energy Resource Research Commission deputy director Lei Shuxuan [7191 2885 5503], State Energy Resource Investment Company chief economist Zhang Quan [1728 0356], China Hydroelectric Power Engineering Society director Wang Baoji [3769 1405 1015], China Electric Power Enterprise Integration Commission technical advisors Du Xingtang [2629 2502 1016] and Zheng Yuanchun [6774 0337 2504] (professor-level senior engineers), and 29 leading comrades and technical experts from the Sichuan Electric Power Industry Bureau,, Central China Electric Power Industry Bureau, Yunnan Provincial Electric Power Bureau, Sichuan Province National Territory Bureau Population Resettlement Office, State Council Three-Line Readjustment Office, Yunnan Provincial Planning Commission National Territory Office, Chang Jiang Water Conservancy Commission, Central Water Conservancy and Hydropower Planning and Design Academy, Academy of Water Conservancy and Hydropower Sciences, Chengdu Survey and Design Academy, Kunming Survey and Design Academy, Southwest China Electric Power Design Academy, and Central China Electric Power Industry Bureau Economic Dynamics Department.

Longtan Update

40100074a Beijing CHINA DAILY (Business Weekly) in English 12 Aug 91 p 1

[Text] A new hydropower station is to be built on the Hongshui River during the Eighth 5-Year Plan period (1991-95) to help speed up development in Guangdong and Guizhou provinces and Guangxi Zhuang Autonomous Region.

The Longtan Power Station will be built according to the normal water level of the Hongshui River and is designed to have an installed capacity of 4.2 million kilowatts.

The station will be a share-holding project and a board of directors from the State Energy Investment Corporation, and the local governments of Guangdong, Guangxi and Guizhou will be established to supervise construction.

Qixing Reservoir Station Completed, Generating Power

916B0077A Nanchang JIANGXI RIBAO in Chinese 11 Jun 91 p 1

[Article by reporters Yang Min [2799 2404] and Xin Chun [2450 2504]: "Guangfeng Qixing Reservoir Completed and Generating Power, Total Reservoir Capacity of Nearly 100 Million Cubic Meters, Will Generate 23.84 million kWh of Power Annually on the Average"]

[Text] After more than 5 years of arduous struggle by large numbers of engineering and technical personnel and workers, Qixing reservoir at Guangfeng, a key construction project in Jiangxi Province during the Seventh 5-Year Plan, has been completed and formally began generating power on 6 Jun 91.

Qixing reservoir, located at Shiwudu Harbor on the upper reaches of the Xin Jiang, is a "tap" project for hydraulic cascade development at Shiwudu Harbor. The 71.1 meter-high concrete stone-faced arch dam at the reservoir is the highest dam in Jiangxi Province. It controls a basin covering 219 square kilometers, has a normal water impoundment level at an elevation of 339.5 meters above the Yellow Sea and a corresponding surface water area of 3.86 square kilometers, and a total reservoir capacity of 99.86 million cubic meters. It is a mid-sized key project focused on electric power which will also be used for flood prevention, irrigation, aquaculture, and other forms of comprehensive utilization.

Completion of Qixing reservoir will provide an adequate power source for industrial and agricultural production in Guangfeng County, guarantee that 20,000 mu of farmland is not threatened by flooding and provide sufficient water sources for irrigation of 100,000 mu of farmland in the downstream area, and ensure stable and high output in agriculture. It also provides rather broad prospects for developing fishery, water-borne shipping, and tourism.

During the construction process, large numbers of builders fostered a spirit of meticulous attention to detail and overcame many problems to achieve smooth progress and safety in construction and complete their project construction tasks with superior quality. Formal testing of the generators for power generation began in April 1991. The project as a whole can generate 23.84 million kWh of power annually on the average.

Lijiaxia Update

916B0077B Xining QINGHAI RIBAO in Chinese 30 May 91 p 1

[Article by reporters Han Wa [3352 3907] and Liu Shi [0491 4258]: "State Ministry of Energy Resources, Qinghai Provincial Government, and Other Units Together with Specially-Invited Experts Study Decision on Diversion Closure at Lijia Gorge Hydropower Station in Fall of 1991"]

[Text] A decision has been made to divert the flow in September and October 1991 at the large Lijia Gorge hydropower station now under construction. This decision was made after inspection of the "Huang He Lijia Gorge Hydropower Station Diversion Closure Program Report" on 25 May 91 by delegates from 17 units including the Qinghai Provincial Government, State Ministry of Energy Resources, State Energy Resource Investment Company, Northwest China Electric Power Management Bureau and specially-invited hydropower experts.

After arduous struggle by more than 3,000 builders at Lijia Gorge hydropower station for almost 4 years, the initial conditions now exist for the diversion closure project. Delegates and experts from the relevant departments agreed upon the diversion standards, diversion closure arrangement, flow rate, and time for diversion closure recommended in the "Diversion Closure Program Report".

The diversion standards are based on a design for floods that occur at a frequency of once every 20 years at 2,000 m^3/s and took into consideration floodwaters that exceed the standard and raising of the height of upstream and downstream dikes at a 2,500 m^3/s flow rate. Based on the terrain characteristics and construction site at the Lijia Gorge hydropower station key facility, a single-support dike vertical blocking diversion closure arrangement was employed moving from the right bank toward the left bank of the Huang He. Given the preparations for the diversion closure, the actual progress in the dam abutment cleavage slope project, and population resettlement arrangement work, the actual diversion closure time was set at mid-September through October of 1991. Due to regulation and impoundment at Longyang Gorge reservoir upstream on the Huang He and other combinations of favorable factors, a diversion closure flow rate of 600 m^3/s was used for construction preparations.

Other units participating in this inspection work included the Upper Huang He Hydropower Project Construction Bureau, Northwest China Hydropower Survey and Design Academy, China Water Conservancy and Hydropower Engineering Corporation, Central Water Conservancy and Hydropower Planning and Design Academy, Jiangxi Provincial Planning Commission, Jiangxi Provincial Key Project Support Office, Jiangxi Provincial Huang He Support Office, 4th Hydropower Bureau, Shaanxi Hydropower Engineering Bureau, Huang He Middle and Upper Reaches Water Transfer Office, Northwest China Electric Power Management Bureau Central Dispatching Office, Qinghai Province Branch of the Bank of Construction, and other units. Qinghai Provincial vice governor Wu Cheng [0702 2110] addressed the meeting.

State Council Decides To Step Up Tarim Oil Exploration

916B0078A Shanghai WEN HUI BAO in Chinese 29 Jun 91 p 1

[Article: "State Council Decides Bank of China Will Provide $1.2 Billion Loan To Accelerate Development of Tarim Oil; Li Peng, Zou Jiahua [6760 1367 5478], Zhu Rongji [2612 6954 1015], Li Guixian [2621 6311 7639] Attend Loan Agreement Signing Ceremony"]

[Text] The State Council decided on 27 Jun 91 that the Bank of China will provide a loan of $1.2 billion to the China Petroleum and Natural Gas Corporation to accelerate exploration and development work at Tarim oilfield. State Council premier Li Peng and vice premiers Zou Jiahua and Zhu Rongji, State Council member Li Guixian, and others attended the loan agreement signing ceremony in Ziguang Pavilion at Zhongnanhai. China Petroleum and Natural Gas Corporation general manager Wang Tao [3769 3447] and Bank of China president Wang Deyan [3769 1795 5888] signed the agreement.

Before the signing of the agreement, Premier Li Peng met with all those attending the ceremony. He pointed out that development and utilization of Tarim's oil and gas resources is of extremely major strategic significance for economic development and social construction in China over the next decade and even into the next century After a long period of arduous effort, especially work done over the past several years, major breakthroughs have been achieved in certain regions and oil and gas reserves on a substantial scale have been proven and controlled. The development prospects are encouraging and no time should be wasted in carrying out development and utilization.

Turpan-Hami Update: Four New Oil Fields Found

916B0078C Changsha HUNAN RIBAO in Chinese 3 Jun 91 p 4

[Article by reporters Wang Zhenshan [3769 2182 1472] and Ma Huibang [7456 2585 6721]: "Reports of Victory in Initial Battles in the War for Turpan-Hami Petroleum, Four New Oil Deposits Already Explored and Discovered, 80 Percent of Drill Rigs Already Drilling"]

[Text] As the daytime summer temperatures in the Huoyanshan region continue to rise, exploration and development work in the battle for Turpan- Hami petroleum also is also gradually heating up.

At Shanshan (Piqan), we saw large-scale shipments of crude oil transmission and petroleum development equipment being shuttled around and a forest of derricks, their machinery roaring, standing in the Gobi desert for several 10 kilometers around the newly-discovered Shanshan oil deposit. Several huge, tall oil storage tanks were rising from the ground and there are pipelines crisscrossing on the ground. The petroleum workers who came from Yumen, North China, and Changqing oilfields are in a heated battle, struggling against the summer heat, fighting for speed and time, and engaging in vigorous labor competition. They are now involved in a day and night battle to build a modernized oilfield at vanguard levels in China.

The battle at Turpan-Hami is an advance battle in China's stabilization of the petroleum industry in east China and making a strategic shift to west China. To fight a good battle at Turpan-Hami, the China Petroleum and Natural Gas Corporation has transferred crack troops and powerful commanders from all over China and established a Turpan-Hami petroleum battle headquarters in February 1991. They also decided to implement a new administrative system, employ advanced technology from China and foreign countries, implement the principle of high levels and high benefits in oilfield development, and are fighting to create a new model for oilfield development in west China.

The battle for Turpan-Hami began in September 1987. Four new oil deposits have been discovered at Shanshan, Qiuling, Yilahu, and Wenjisang. High-output condensed oil and gas flows were obtained from the Wen 1 well on 12 Apr 91. Forecasts by experts indicate that this will be another large oil and gas deposit with considerable combined oil and gas reserves following Shanshan oil deposit and that there are gratifying prospects of a group of oil and gas deposits spreading throughout the entire basin.

Now the number of employees fighting the battle at Turpan-Hami has grown from 5,000 at the beginning of 1991 to more than 13,000, while 80 percent of the drill rigs have already begun drilling and have completed a drilling footage of 125,000 meters. There are 16 of 36 oil wells which have already gone into operation. The time spent on moving and installing drilling rigs and starting to drill has been reduced from 7 days in the past to 9 hours and 40 minutes. The vanguard development experiment station at Shanshan has already gone into operation and the battle of Turpan-Hami has moved from the exploration into the initial development stage. Construction has already begun on oil and materials storage facilities, dedicated railway lines, and the corresponding communications, highway, power supply, and other surface projects. A 500,000- ton production capacity may be formed during 1991 and 200,000 tons of oil extracted.

New Discoveries in Shengli Oil Field

40100074b Beijing XINHUA in English 0245 GMT 6 Aug 91

[Text] Ji'nan, August 6 (XINHUA)—Geological prospecting in the Shengli Oilfield in east China's Shandong Province has resulted in significant new finds this year.

Shuai Defu, general geological engineer of the Shengli Oilfield Administration, said that this year 10 test wells have been drilled in Gaoqing County near Zibo City, and

oil has been found in all of them, with layers ranging from 20 m to 100 m in thickness.

As a result, a new oilfield with an estimated reserve of 50 million tons has been proved. In addition, oil has also been found in five test wells drilled in the Chengdao offshore area of Bohai Bay; among them the Chengbei-21 well has achieved a daily output of 123 cu m to 137 cu m of crude oil, and the Chengbei-11 well has also found oil layers from 50 m to 60 m in thickness.

Shuai said that the administration is now working on the Chengbei-3 inclined well and has decided to drill the Chengbei-25 well. If oil is found in these two wells it will prove that the offshore Chengdao Oilfield is connected with the Zhuangxi Oilfield on the land, and an additional oil-bearing area of eight sq km and a reserve of 20 million tons will also be confirmed. He predicted that a new reserve of 40 million tons will be proved in the area this year, raising the proved geological reserve of Chengdao Oilfield to over 100 million tons.

Another new find—a fault block oilfield—is in the Laohekou area east of the Chengdong Oilfield. Because it was tapped with the latest "horizontal well technique", it is called the "horizontal oilfield". Two wells have already been drilled here; the test well—Chengke-1 declined well—found 19 oil layers with a total thickness of 211.5 m. Two test wells have been drilled in the depression area of Huimin Prefecture, both of which discovered oil. This area is capable of becoming a medium-sized oilfield.

The adoption of new technologies such as three-dimensional seismic prospecting has helped greatly in the search for new resources of oil, Shuai said. He predicted that this year's newly-proved oil reserves at Shengli will reach 100 million tons.

The Shengli Oilfield, situated on the delta of the Huanghe River, is China's second-largest oilfield. It was discovered in 1961 and went into production in 1964. In the past 30 years some 64 oil deposits have been found here, with a total proved oil reserve of several billion tons and a gas reserve of tens of billions of cu m. In 1989 the total oil output topped 33 million tons.

Oil, Gas Layers Found on Southern Slopes of Altun Shan

916B0078B Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 7 Jun 91 p 2

[Article by Yi Shanfeng [2496 0810 6912] and Zhang Qirui [1728 0796 6904]: "Field Geology Survey Indicates Discovery of Petroliferous Strata on Southern Slopes of the Altun Shan"]

[Text] The Chinese Academy of Sciences Geology Institute in cooperation with the Qinghai Petroleum Management Bureau Scientific Research Academy to conduct geological survey research has discovered that the southern slopes of the Altun Shan is a nappe that covers the surface of the northwestern region of Qaidam Basin. Mesozoic strata 5 to 6 kilometers thick were discovered beneath the nappe, including strata about 2,000 meters thick similar to the primary oil and gas generating and reservoiring systems in the basin. Oil sands over 500 meters thick have already been discovered in these strata at the margins of the nappe. Considering that this nappe extends eastward and westward along the southern slopes of the Altun Shan and the possibility that it may broaden moving inward toward the mountain, this prospective oil and gas region may be further expanded, which would open up a new direction for oil and gas exploration in Qaidam Basin.

Nappe structures are geological phenomena that have received extremely close attention internationally over the past few years, and they may provide new prospects for prospecting and exploration for oil and gas and other minerals. The discovery of the oil and gas prospects of the nappe on the southern slopes of the Altun Shan and the area beneath it is a breakthrough from the ideological confinement that oil and gas in Qaidam Basin would not extend beyond the base of the mountain and is of universal significance for oil and gas prospecting work in several basins.

The China Petroleum and Natural Gas Corporation is extremely concerned with this point. The corporation's Prospecting Bureau convened an academic conference not long ago to discuss and confirm this achievement, and it made deployments for further research and exploration work.

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